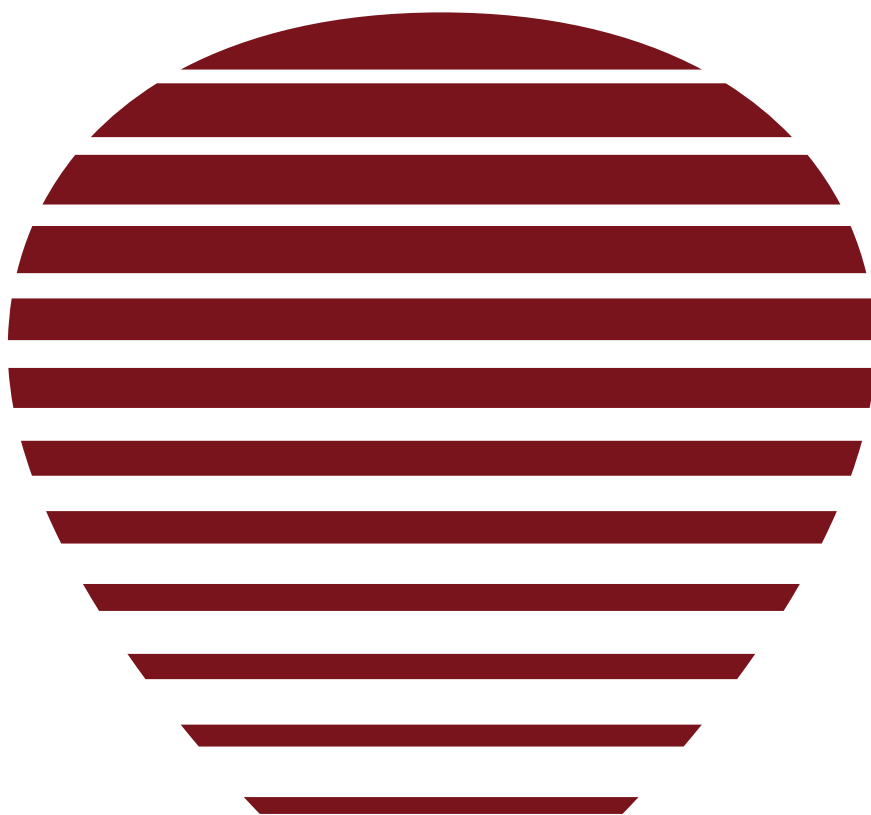




RADECS
austria
CONFERENCE 2010

11TH EUROPEAN CONFERENCE ON
**RADIATION AND ITS EFFECTS ON
COMPONENTS AND SYSTEMS**

20-24 SEPTEMBER, 2010
AQUA DOME LÄNGENFELD, AUSTRIA

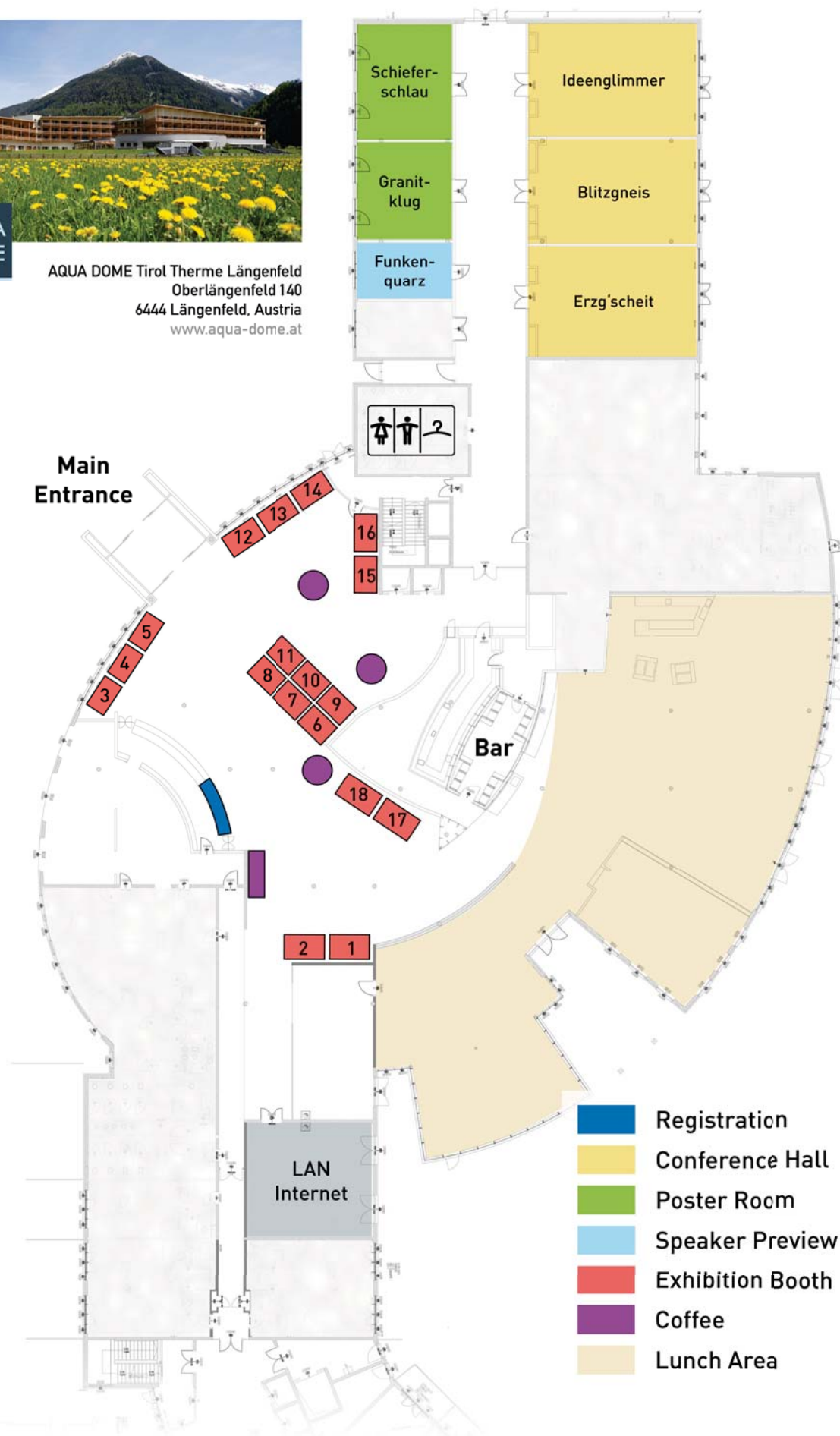
CONFERENCE BOOKLET

Conference Venue



**AQUA
DOME**

AQUA DOME Tirol Therme Längenfeld
Oberlängenfeld 140
6444 Längenfeld, Austria
www.aqua-dome.at



Programme at a Glance

Time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
07:30		Registration	Registration	Registration	Registration	
08:30			08:15 Conference Opening			08:30 Invited Talk RADECS - Future after 20 Years <i>J. Gasiot</i>
09:00		09:00 Thematic Workshops	09:00 Invited Talk Cosmic Radiation <i>S. Schindler</i>	08:45 Session E	08:45 Session G	
09:30	9:30 – 16:00		09:40 Session A	09:35 Session F		09:30 Presentation Thematic Workshops
10:00	Sunday Tour			10:10 Coffee Break	10:05 Coffee Break	
10:30		10:20 Coffee Break	10:30 Coffee Break	10:40 Session F	10:35 Session H	10:30 Coffee Break
11:00		10:50 Thematic Workshops	11:00 Session B			10:50 Session I
11:30						
12:00		12:10 Lunch	12:20 Lunch	11:55 Lunch	11:55 Lunch	11:40 Session J
12:30						12:30 Closing
13:00						13:00 Lunch
13:30		13:40 Thematic Workshops	13:50 Invited Talk Jupiter Europa Orbiter <i>K. B. Clark</i>	13:25 Invited Talk Tyrolean Iceman <i>A. Zink</i>	13:25 Invited Talk Radiation Damage in Nanometre Sized Volumes <i>B. Grosswendt</i>	
14:00			14:50 Session C	14:25 Radiation Effects Data Workshop	14:25 Poster Session	
14:30			15:40 Coffee Break			
15:00		15:00 Coffee Break		16:00 End of Sessions		
15:30		15:30 Thematic Workshops	16:10 Session C	16:30 Departure for Tyrol Evening	16:30 RADECS General Assembly	
16:00			16:55 Session D			
16:30			17:45 End			
17:00	17:00 – 19:00 Registration	17:00 End of Sessions	18:00 – 19:30 Welcome at the Conference Hotel		18:00 End of Sessions	
17:30						
18:00						
18:30						
19:00		19:00 - 20:30 Reception at the Town Hall Längenfeld				
19:30					19:30 - 23:00 Gala Dinner	

Table of Contents

Programme at a Glance	1
RADECS 2010 Programme Committee	3
List of Official Reviewers	4
Chairman's Invitation	5
Thematic Workshops – Monday, 20 September 2010	6
Technical Programme – Overview	8
Technical Programme – Tuesday, 21 September 2010	8
Invited Talk:	
Victor Hess an Austrian Nobel Prize Winner and 100 Years of Cosmic Radiation	9
Session A: Basic Mechanisms	9
Session B: Devices and Integrated Circuits	11
Invited Talk:	
Jupiter Europa Orbiter – Challenging Engineering for Exceptional Science	13
Session C: Single Event Effect 1: Mechanisms and Modeling	13
Session D: Photonics	16
Technical Programme – Wednesday, 22 September 2010	18
Session E: Space and Terrestrial Environments	18
Session F: Single Event Effect 2: Devices and Integrated Circuits	20
Invited Talk:	
New Insights into the Life and Death of the Tyrolean Iceman	23
Radiation Effects Data Workshop	23
Technical Programme – Thursday, 23 September 2010	27
Session G: Radiation Hardness Assurance	27
Session H: Technology and Design Hardening	29
Invited Talk:	
Radiation Damage: Particle Interactions in Nanometre-sized Volumes, a Challenge for Radiation Physics and Life Science	31
Posters and Late News	32
RADECS General Assembly	34
Technical Programme – Friday, 24 September 2010	35
Invited Talk:	
Looking for the future after twenty years of RADECS	35
Presentation Thematic Workshops	35
Session I: Ground Level Effects	35
Session J: Dosimetry and Facility	37
Awards	39
Industrial Exhibition – 20-23 September 2010	40
General Conference Information	44
Travel Information	45
Social Programme and Tours	46
RADECS 2010 Sponsors	52

RADECS 2010 Programme Committee



Peter Beck
General Chair
(AIT Austrian Institute of Technology)



Laurent Dusseau
Vice Chair
(University of Montpellier 2)



Jerome Boch
Technical Chair
(University of Montpellier 2)



Marcin Latocha
Technical Vice Chair
(AIT Austrian Institute of Technology)

Organizing Committee

General Chair	Peter Beck , AIT Austrian Institute of Technology
General Vice-Chair	Laurent Dusseau , University of Montpellier 2
Technical Chair	Jerome Boch , University of Montpellier 2
Technical Vice-Chair	Marcin Latocha , AIT Austrian Institute of Technology
Local Arrangements	Lukas Buchhammer , Aqua Dome Sascha Rössel , Aqua Dome Gernot Grömer , Austrian Space Forum Michael Wind , AIT Austrian Institute of Technology
Public Relations – Industrial Exhibition	Teresa Farris , Aeroflex Colorado Springs Christian Chatry , TRAD, Test and Radiation Christian Laa , RUAG Austrian Aerospace
Poster Session Chair	Antoine Touboul , University of Montpellier 2 Philippe. Adell , NASA
Radiation Effects Data Workshop	Christian Poivey , ESA European Space Agency Nick Van Vonno , Intersil
Thematic Workshops	Robert Ecoffet , CNES Alessandro Paccagnella , University Padova Janet Barth , NASA Eamonn Daly , ESA David Edwards , NASA
Guest Editor IEEE TNS	Jim Schwank , Sandia National Laboratories
Conference Proceedings	Jean-Luc Autran , L2MP-CRNS
Awards Chair	Ronald Schrimpf , Vanderbilt University Marie C. Palau , EADS
Conference Registration	Margit Malatschnig , Techkonnex – High-Tech Promotion Sofia Rollet , AIT Austrian Institute of Technology Andrea Zechner , AIT Austrian Institute of Technology
Conference Web site	Marcin Latocha , AIT Austrian Institute of Technology Michael Beck
Technical Web site	Jerome Boch , University of Montpellier 2

Advisory Committee

Janet Barth , NASA	Otto Koudelka , Graz University of Technology
Wolfgang Baumjohann , Academy of Science, Graz	Ralf de Marino , European Space Agency (ESA)
Uwe Bratzler , CERN / IEEE/ NPSS	Steven S. McClure , NASA
Hubert Brückl , AIT Austrian Institute of Technology	Peter McNulty , Clemson University
Philippe Calvel , RADECS	Harald Posch , Austrian Research Promotion Agency FFG
Robert Ecoffet , Centre National d'Etudes Spatiales (CNES)	Günther Reitz , German Aerospace Center (DLR)
Kenneth Galloway , Vanderbilt University	Sergey Zykov , International Atomic Energy Agency (IAEA)
Jean Gasiot , University Montpellier 2	

List of Official Reviewers

Adell, P.	JPL	Malou, F.	CNES
Alexander, D.	AFRL	Mangeret, R.	Astrium
Alvarez, M.	INTA	Mantelet, G.	ATMEL
Autran, J. L.	University of Provence	Marec, R.	THALES ALIENA SPACE
Barillot, C.	Thales Alenia Space	Marin, M.	Thales Alenia Space
Barnaby, H.	Arizona State University	Markgraf, M.	DLR
Barth, J.	NASA/GSFC	Marshall, P.	GSFC/Consultant
Baumann, R.	TI	Massengill, L.	Vanderbilt University
Benoit, D.	CHU Tours	Mathes, M.	Fraunhofer INT
Berger, G.	UCL	Matias-Vaillé, S.	Oncogard
Bezerra, F.	CNES	Mattsson, S.	RUAG
Bhuva, B.	Vanderbilt University	Mayer, D.	The Aerospace Corp.
Boatella, C.	CNES	McClure, S. S.	CalTech Jet Propulsion Laboratory
Bouchet, T.	Astrium	McLain, M.	Arizona State University
Bougerol, A.	EADS	McNulty, P.	Clemson University
Boulghassoul, Y.	ISI	Mélotte, M.	Thales Alenia Space ETCA
Bourdardie, S.	ONERA	Metzger, S.	Fraunhofer INT
Brant, C.	Univ Colorado	Miller, F.	EADS
Brichard, B.	SCK	Mohammadzadeh, A.	ESA
Brugger, M.	CERN	Moll, M.	CERN
Buchner, S.	NRL	Nickson, B.	ESA/ESTEC
Busatto, G.	University of Cassino	Nieminen, P.	ESA/ESTEC
Canal, A.	TRAD	Oldham, T.	NASA GSFC
Carrière, T.	EADS ST	Paccagnella, A.	University of Padova
Caussanel, M.	Université Perpignan	Paillet, P.	CEA
Cellere, G.	Università di Padova	Pease, R.	RLP Research
Chatry, C.	TRAD	Pellish, J.	NASA- GSFC
Chaumont, G.	STN	Peyre, D.	EADS Astrium
Chugg, A.	MBD	Pimenta, M.	Lisbon Institute of Physics
Clark, L.	Arizona State University	Poivey, C.	ESA ESTEC
Cueto, J.	TAS	Poizat, M.	ESA
David, J.-P.	ONERA	Pouget, V.	IMS laboratory
Dusseau, L.	University Montpellier 2	Pribyl, W.	TU GRAZ
Duzellier, S.	ONERA DESP	Pritchard, B.	Northrop-Grumman
Eichberger, B.	TU-Graz	Rakers, S.	Astrium Space Transportation
Eriksson, K.	Saab Space	Ratti, L.	Università di Pavia
Evans, H.	ESA/ESTEC	Ravotti, F.	CERN
Faccio, F.	CERN	Reed, R.	Vanderbilt University
Fleetwood, D.	Vanderbilt University	Reineke, N.	Astrium
Gaillard, R.	RG	Remmerie, C.	TAS
Girad, S.	CEA/DIF BP12	Rezgui, S.	Actel
Glaser, M.	CERN	Roche, N.	University of Montpellier
Gliem, F.	IDA Braunschweig	Rolland, G.	CNES
Gonzalez Velo, Y.	University Montpellier 2	Rosenfeld, A.	University of Wollongong
Granhölm, L.	Swedish Space Corporation	Sagnes, B.	University of Montpellier
Granlund, T.	Saab Communication	Saigné, F.	University of Montpellier
Guerrero, H.	INTA	Salvaterra, G.	EADS Astrium
Gusarov, A.	SCKCEN	Sarrabayrouse, G.	CNRS-LAAS
Hafer, C.	Aeroflex	Scheick, L.	JPL
Hajdas, W.	Paul Scherrer Institut	Schmitz, T.	Intersil
Hansen, D.	Boeing	Schrimpf, R.	Vanderbilt University
Heijmen, T.	NXP	Schütttauf, A.	EADS Astrium ST
Herve, D.	Sodern	Scott, K.	Ball Aerospace
Heynderickx, D.	DHC	Shaneyfelt, M. R.	Sandia National Laboratories
Hiemstra, D.	MDA	Sharp, R.	Isotron
Höfftgen, S. K.	Fraunhofer INT	Simoen, E.	IMEC
Holmes-Siedle, A.	REM	Srour, J.	Aerospace Corp
Hopkinson, G.	Surrey Satellite Technology	Sturesson, F.	ESA
Ikedo, N.	JAXA	Sylvain, G.	CEA
Insoo, J.	JPL	Tausch, J.	JD Instruments
Jaksic, A.	Tyndall National Institute	Tavlet, M.	CERN
Johnston, A.	JPL	Tomashuk, A.L.	Fiber Optics Research Center
Jun, I.	NASA JPL	Touboul, A.	MONTPELLIER UNIVERSITY
Kastensmidt, F.	Instituto de Informática	Truscott, P.	QinetiQ
Kuboyama, S.	JAXA	Vaille, J.-R.	UM2
Kuhnhehn, J.	Fraunhofer Int	Valtonen, E.	University of Turku
Label, K.	NASA	van Uffelen, M.	SCK-CEN, Belgium
Labury, R.	NASA	Van Vonno, N.	INTERSIL
Lawrence, R.	Bae	Vermeire, B.	Arizona State University
Leray, J. L.	CEA	Virtanen, A.	RADEF
Leroux, P.	KHK	von Przewoski, B.	Indiana University
Lorfevre, E.	CNES	Weller, R. A.	Vanderbilt University
Lum, G.	Lockheed-Martin	Weulersse, C.	EADS
Luu, A.	UCL	Wijnands, T.	CERN
Maget, V.	ONERA	Wrobel, F.	UM2
Magnes, W.	Academy of Science, Graz, Austria	Xapsos, M.	NASA/GSFC

Chairman's Invitation



Peter Beck
(AIT)

On behalf of the RADECS (Radiation and its Effects on Components and Systems) Association, it is my pleasure to invite you to attend the RADECS 2010 Conference to be held September 20-24, 2010 at the Aqua Dome Hotel in Längenfeld, close to Innsbruck, Austria. The conference theme of RADECS 2010 is: "Effects in Micro- and Nanometer Site Sizes due to Radiation Exposure". The 11th edition of the International RADECS Conference is organized by AIT Austrian Institute of Technology in collaboration with the University of Montpellier 2 and partners. The conference features a technical program dedicated to the latest developments and experimental observations. The technical programme is based on critically reviewed presentations describing nuclear and space radiation effects on electronics and photonic materials, devices, circuits, sensors, and systems. Very important for RADECS is the close collaboration link to the industry, which supports the conference. We are very proud that the conference hosts an "Industrial Exhibition", a "Radiation Effects Data Workshop" and new "Thematic Workshops".

As a new topic "Ground Level Effects" was suggested for RADECS 2010. Several very interesting papers to this topic were sent for evaluation. Further innovations of RADECS 2010 are the so called "Thematic Workshops" to be held on Monday 20 September. Three Thematic Workshop topics were identified as most interesting for the RADECS 2010 conference participants: "Space Weather Issues", "International Irradiation Facilities", and "Radiation Effects on Non Volatile Memories".

The Conference Location is in the vicinity of a historical place for cosmic radiation. The Austrian Nobel Prize winner and cosmic radiation discoverer, Victor Hess, worked at the University Innsbruck. His mountain laboratory is at 2300 m (~7600 ft) of altitude. The Ötztal valley is also well known for the so called "Ötzi", the Iceman, a well-preserved natural mummy of a man from about 3300 BC (53 centuries ago). Famous touristic places are Sölden, Obergurgl, and Hochgurgl up to 3000 m (~9900 ft) altitude. Tours will be organized to well known places such as Meran in Italy, the castle Neuschwanstein in Germany, Swarovski Kristallwelten at Wattens, the Mozart town Salzburg, and to Munich - famous for its Oktoberfest during September. Moreover, the location offers fantastic mountain sceneries and the possibility of hiking tours along the 150 km of marked trails along the Ötztal valley. The weather in September is usually stable around 15°C (59°F) with sunshine. You should be prepared for changes as it is usual in a mountain area (1200 m ~4000 ft altitude). The friendly environment and the close contact with the lovely nature will encourage discussions between the attendees. The Aqua Dome Spa offers excellent recreation after the conference day, with your family, friends or colleagues. Together with outstanding Austrian food and wine your stay will be relaxing and enjoyable.

The Thematic Workshops are coordinated by Robert Ecoffet, supported by several very experienced workshop chairs. The Technical Chair, Jerome Boch and his technical team have assembled an interesting technical program organized in 11 sessions of oral and poster presentations. Five outstanding invited talks will be given by internationally recognized personalities. Teresa Farris and Christian Chatry, the Industrial Exhibit Chairpersons have gathered a panel of 17 exhibitors. Companies working in areas related to the field of radiation effects, microelectronics, design, tests and space application will exhibit their products in the entrance hall of the Conference Hotel Aqua Dome. To get students involved in the community a support program was established. In particular the Jean Marie Palau Award was created for this purpose in the past.

On Monday, 20 September, an evening reception will take place in the town hall of Längenfeld. A Welcome Cocktail for all attendees and their guests will be served on Tuesday, 21 September evening in the area of the Industrial Exhibition. On Wednesday, 22 September a traditional "Tiroler Abend" (Tirol Evening) is organized. For the Gala Dinner, on Thursday 23 September, its location will be kept secret, but I promise you unforgettable moments as usual during a RADECS Gala Dinner. See you in Längenfeld at the RADECS Austria 2010!

Thematic Workshops – Monday, 20 September 2010

07:30 Registration

09:00 Thematic Workshops

Thematic Workshops are held in the conference area, parallel in three seminar rooms: "Ideenglimmer", "Blitzgneis", and "Erzg'scheid".

Coordination: Robert Ecoffet



Robert Ecoffet

TW-1 Space Weather Issues

Chairs: Janet L. Barth; *NASA*, Eamonn Daly; *ESA*, David L. Edwards; *NASA*

TW-2 International Irradiation Facilities

Chair: Robert Ecoffet; *CNES*

TW-3 Radiation Effects on Non Volatile Memories

Chairs: Alessandro Paccagnella, Simone Gerardin; *University of Padova*

09:00 Thematic Workshop Session 1

TW-1: Space Weather Issues	TW-2: International Irradiation Facilities	TW-3: Radiation Effects on Non Volatile Memories
▪ Welcome and Introduction ▪ Agency programmes related to space weather radiation effects - ESA SSA programme - NASA and US programmes - Concept for an Applied Spaceflight Environments Office - Other programmes	▪ Welcome and Introduction ▪ Sources and Accelerators - Europe - USA and Canada - Russia - Japan	▪ Welcome and Introduction ▪ Requirements for NVMs in radiation environments

10:20 Coffee Break

Thematic Workshops – Monday, 20 September 2010

10:50 Thematic Workshop Session 2

TW-1: Space Weather Issues	TW-2: International Irradiation Facilities	TW-3: Radiation Effects on Non Volatile Memories
▪ Recent activities on space weather effects on spacecraft - Planning operations to avoid device failure on METOP - Galileo radiation environment and its monitoring - Development and deployment of space weather monitoring equipment	▪ Laser facilities ▪ Micro-beams ▪ High energy ion beams	▪ Radiation effects on NVMs

12:10 Lunch

13:40 Thematic Workshop Session 3

TW-1: Space Weather Issues	TW-2: International Irradiation Facilities	TW-3: Radiation Effects on Non Volatile Memories
▪ Discussions - Approaches to design for and operate in the Space Environment / Space Weather	▪ Low energy proton beams ▪ Electron beams ▪ Neutron facilities	▪ Rad-hard NVMs

15:00 Coffee Break

15:30 Thematic Workshop Session 4

TW-1: Space Weather Issues	TW-2: International Irradiation Facilities	TW-3: Radiation Effects on Non Volatile Memories
▪ Summary and conclusions	▪ Discussions ▪ Summary and conclusions	▪ Future developments ▪ Conclusions RAD-hard NVMs

17:00 End of the session

19:00 Reception at the Town Hall Längenfeld

Technical Programme – Overview



Jerome Boch
(UM2)

The RADECS 2010 technical programme consists of oral and poster papers and a Radiation Effects Data Workshop. All oral presentations are scheduled for 12 minutes in length with an additional 3 minutes for questions. The technical sessions are:

Session A: Basic Mechanisms

Chair: Stefan Metzger and Robert A. Weller

Session B: Devices and Integrated Circuits

Chair: Françoise Bezerra and Wolfgang Pribyl

Session C: Single Event Effect 1: Mechanisms and Modeling

Chair: Ronan Marec and Sven Rakers

Session D: Photonics

Chair: Maite Alvarez and Benoit Brichard

Session E: Space and Terrestrial Environments

Chair: Sébastien Bourdarie and Richard Sharp

Session F: Single Event Effect 2: Devices and Integrated Circuits

Chair: Florent Miller and Raymond Ladbury

Session G: Radiation Hardness Assurance

Chair: Stephen Buchner and Ali Mohammadzadeh

Session H: Technology and Design Hardening

Chair: Hugh Barnaby and Philippe Paillet

Session I: Ground Level Effects

Chair: Werner Magnes and Frederic Wrobel

Session J: Dosimetry and Facility

Chair: Federico Ravotti and Jean-Roch Vaille

Radiation Effects Data Workshop

Chair: Christian Poivey and Nick Van Vonne

Posters and Late News

Chair: Philippe Adell and Antoine Touboul

The **Radiation Effects Data Workshop** will be held on Wednesday, 22 September, starting at 14:25 in room “Granitklug”.

The **Poster Session** is held on Thursday, 23 September, starting at 14:25 in the rooms “Schieferschlau” and “Granitklug”.

Late News papers are included in the posters session.

All posters should be ready for viewing latest on Wednesday morning, 22 September, and have to be removed latest by Friday, 24 September, 15:00.

Technical Programme – Tuesday, 21 September 2010

07:30 Registration

08:15 Conference Opening

09:00 Invited talk

Victor Hess an Austrian Nobel Prize Winner and 100 Years of Cosmic Radiation
by Sabine Schindler



***Sabine Schindler** is the Head of the Institute for Astro- and Particle Physics at the University of Innsbruck. Her scientific interests include galaxies and galaxy clusters, which she investigates both with observations and with numerical simulations. She has published far more than 100 articles. She is a member of the Austrian Academy of Sciences.*

In 1912 Victor Franz Hess discovered that the ionising radiation measured in the atmosphere does not come from Earth but it has a cosmic origin. In 1936 he was awarded the Nobel Prize for this discovery. Cosmic rays were and are subject of many investigations. Their energies span a huge range with the origin of the highest energy particles still being unclear. In honour of the Nobel Prize laureate the name for a large telescope was chosen to be HESS: the telescope is investigating gamma rays coming from the universe.

09:40 Session A: Basic Mechanisms

Introduction by Chair: Stefan Metzger and Robert A. Weller



Stefan Metzger



Robert A. Weller

09:45 A-1 NIEL scaling: comparison with measured defect introduction rate in silicon.

P. Arnold¹, C. Inguibert¹, T. Nuns¹, C. Boatella-Polo²;

¹ONERA-DESP; ²CNES

Comparison of theoretical NIEL calculation with measured defect introduction rates leads to define a smoother displacement damage threshold as the one used traditionally.

Technical Programme – Tuesday, 21 September 2010

10:00 A-2 P-channel Power MOSFET SEGR sensitivity to Heavy Ion Range.

*N. Chatry¹, N. Sukhaseum¹, M. Sauvagnac¹, F. Bezerra², R. Ecoffet², R. Gaillard³;
¹TRAD; ²CNES; ³Consultant*

Correlations of SEGR sensitivity with experimental parameters (Range, Deposited charge in EPI layer, VDS thresholds) allow determining a worst case range domain corresponding to the Bragg peak located near the interface of epitaxial and substrate layers.

10:15 A-3 Effect of ionizing radiation on defects and 1/f noise in Ge pMOSFETs.

*C. X. Zhang¹, E. Zhang¹, D. Fleetwood¹, R. Schrimpf¹, K. Galloway¹, E. Simoen², J. Mitard², C. Claeys²;
¹Vanderbilt University; ²IMEC*

The irradiation and annealing responses of Ge-pMOSFETs have been investigated under transmission gate bias. Both the threshold voltage shift and 1/f noise increase with dose and decrease with annealing time.

Posters for the session

PA-1 Modeling of the tunneling current in MOS devices after proton irradiation using a nonlinear series resistance correction.

*F. Palumbo¹, E. Miranda²;
¹CONICET and with CNEA; ²Universitat Autònoma de Barcelona*

The impact of 10 MeV protons on a MOS structure can lead to a significant reduction of the gate leakage current. To simulate this effect we consider a nonlinear series resistance correction in the Fowler-Nordheim tunneling expression.

PA-2 A theoretical analysis of the role of ambipolar diffusion on charge-carrier transport in a quasi-neutral region under high injection.

*L. Edmonds;
NASA JPL*

After explaining the reason that the ambipolar diffusion equation (ADE) found in popular textbooks is not useful for charge-collection investigations, a more useful version of the ADE, the regional ADE is derived.

PA-3 Development of TID-aware MOSFET model and its application.

*L. Ding¹, H.-X. Guo², W. Chen², R.-Y. Fan²
¹Tsinghua University; ²Northwest Institute of Nuclear Technology, China*

TID-aware MOSFET model which address total ionizing dose effect based on foundry model is built considering sub-circuit approximation. This method don't need complicated TCAD simulator and agree well with experimental data.

10:30 Coffee Break

Technical Programme – Tuesday, 21 September 2010

11:00 Session B: Devices and Integrated Circuits

Introduction by Chair: Francoise Bezerra and Wolfgang Pribyl



Francoise Bezerra



Wolfgang Pribyl

11:05 B-1 Verilog-A Modeling of Radiation-Induced Mismatch Enhancement.

M. Gorbunov¹, I. Danilov¹, G. Zebrev², P. Osipenko¹;

¹Scientific Research Institute of System Analysis, Russian Academy of Sciences;

²Moscow Engineering Physics Institute (National Research Nuclear University)

Physical model of TID effects is embedded to BSIM3v3 model implemented using Verilog-A. Radiation-induced mismatch enhancement due to the combined action of technology variations and electrical regime difference is demonstrated by simulation.

11:20 B-2 Modeling Ionizing Radiation Effects in 90 nm Bulk CMOS Devices.

I. Sanchez Esqueda¹, H. J. Barnaby¹, K. E. Holbert¹, Y. Boulghassoul²;

¹Arizona State University; ²Information Sciences Institute East, University of Southern California

An approach for incorporating the effects of TID into surface-potential-based compact models by analytically modeling the buildup of oxide trapped charge using a set of parameters extracted from 2D technology computer aided design (TCAD) device simulations.

11:35 B-3 Performance and TID Radiation Response of a Diamond Vacuum Lateral Field Emission Transistor.

K. Subramanian¹, J. Davidson², W. P. Kang², B. Cho², K. Galloway²;

¹Intel Corp.; ²Vanderbilt University

A nanodiamond lateral field emission vacuum microelectronic transistor and its electronic properties and hardness to high (20 Mrad) dose X ray exposure is described. No changes in the device structure or electrical behavior were observed.

11:50 B-4 Proton-induced mobility degradation in FinFETs with stressor layers and strained SOI substrates.

D. Kobayashi^{1,2}, E. Simoen¹, S. Put², A. Griffoni¹, M. Poizat³, K. Hirose⁴, C. Claeys¹;

¹IMEC; ²EE department, Katholieke Universiteit Leuven; ³ESTEC; ⁴Institute of Space and Astronautical Science, JAXA

FinFETs on tensile-strained and non-strained SOI substrates have been irradiated by 60-MeV protons. Additional use of tensile and compressive stressor layers can exhibit complex effects on radiation-induced mobility degradation depending on the kind of substrates.

Technical Programme – Tuesday, 21 September 2010

- 12:05 **B-5** **Analysis of Total Ionizing Dose Impact on a Typical Current Feedback Amplifier.**
*S. Perez¹, L. Dusseau¹, Y. Gonzalez Velo¹, N. Roche¹, J. Boch¹, J.-R. Vaille^{1,2},
F. Saigne¹, R. Ecoffet³;*

¹IES Université Montpellier II; ²Université de Nîmes; ³CNES

The impact of Total Ionizing Dose on the AD844 Current Feedback amplifier is investigated. Circuit analysis is conducted in order to determine the degradation mechanisms at play with a predictive approach.

Posters for Session B

- PB-1** **1.8 MeV proton radiation effects on substrate resistivity of n-type MOS capacitors.**

*R. Arinero¹, E. X. Zhang², N. Rezzak², R. Schrimpf², D. Fleetwood², B. Choi²,
A. Hmelo², A. Touboul¹, F. Saigne¹;*

¹IES Université Montpellier 2; ²Vanderbilt University

We have irradiated MOS capacitors with 7 nm SiO₂ dielectrics by 1.8 MeV protons. We have observed an increase of the substrate resistivity for fluences higher than $5 \times 10^{12} \text{ cm}^{-2}$, resulting from proton-induced displacement damage.

- PB-2** **Ionizing Radiation Response of Floating Gate Devices under Bias Controlled Cycled Measurement.**

M. Garcia Inza, J. Lipovetzky, E. Redin, S. Carbonetto, A. Faigon;

Facultad de Ingeniería - Universidad de Buenos Aires

Floating Gate Metal Oxide Semiconductor structures, designed and fabricated in a CMOS process, were irradiated under the Bias Controlled Cycled Measurement novel technique conditions. Measurements results are presented.

12:20 **Lunch**

Technical Programme – Tuesday, 21 September 2010

13:50 Invited talk

Jupiter Europa Orbiter – Challenging Engineering for Exceptional Science

by Karla B. Clark



Karla B. Clark has Bachelor's degrees in Chemistry and Chemical Engineering from Rice University and Master's degrees in Mechanical Engineering and Engineering Management from the University of Southern California. She has held several technical positions in the research and technology development area. She was the manager for the Cassini Power Subsystem and worked on earlier instantiations of the Europa mission concepts since 1997. Karla was the Flight system Manager for the Jupiter Icy Moons Orbiter (Prometheus Nuclear Reactor Program) and led the NASA Study for the last 3 years to get the NASA-ESA Joint Mission - Europa Jupiter System Mission. Jupiter Europa Orbiter is the NASA contribution to the Europa Jupiter System Mission. Recently she left the Jupiter Europa Orbiter to take over the Mission Assurance Directorate at JPL which includes all electronic parts, reliability and quality assurance activities.

I will describe the Jupiter Europa Orbiter mission concept including the science that would result from this mission. Tentatively scheduled to launch in 2020, this mission would spend 3-4 years in the radiation belts of Jupiter and would provide unprecedented science opportunities. The challenge of both the spacecraft and science instruments functioning in the radiation flux and after accumulating significant total dose provides the opportunity for the engineering community to apply ingenuity and creativity to the designs. System engineering, hardware, software, mission design and operational solutions would be combined to enable the mission to be successful and will be described.

14:50 Session C: Single Event Effect 1: Mechanisms and Modeling

Introduction by Chair: Ronan Marec and Sven Rakers



Ronan Marec

Sven Rakers

14:55 C-1 Direct Comparison of Charge Collection from Single-Photon and Two-Photon Laser Testing Techniques.

J. Schwank¹, M. Shaneyfelt¹, P. Dodd¹, D. McMorrow², G. Vizkelethy¹, V. Ferlet-Cavrois³, P. Gouker⁴, R. Flores¹, J. Stevens¹, S. Dalton¹, S. Swanson¹;

¹Sandia National Laboratories; ²Naval Research Laboratory; ³ESA/ESTEC;

⁴MIT Lincoln Laboratory

The amounts of charge collection by single-photon absorption to that by two-photon absorption laser testing techniques have been directly compared using specially made SOI diodes. Details of this comparison are discussed.

Technical Programme – Tuesday, 21 September 2010

15:10 C-2 Heavy-Ion Induced Threshold Voltage Shifts in Sub 70-nm Charge-Trap Memory Cells.

S. Gerardin¹, M. Bagatin¹, A. Paccagnella¹, G. Cellere², A. Visconti³, E. Greco³;

¹DEI - Padova University and with INFN; ²Applied Materials Baccini; ³Numonyx, R&D, Technology Development

We investigate threshold voltage shifts induced by heavy ions in sub 70-nm charge-trap cells and compare the results with floating gate memories. These devices are expected to substitute current NAND memories in the near term.

15:25 C-3 Impact of Process Variations on SRAM Single Event Upsets.

A. Kauppila, B. Bhuvu, J. Kauppila, L. Massengill, T. Holman;

Vanderbilt University

Process variations affect the single event (SE) hardness of SRAM cells. Monte-Carlo simulations show this effect and can be used to quantify the significance of process parameter shifts on SRAM SE upset rates.

15:40 Coffee Break

16:10 C-4 Impact of the Radial Ionization Profile on SEE Prediction for SOI Transistors and SRAMs Beyond the 32 nm Technological Node.

M. Raine¹, G. Hubert², L. Artola², M. Gaillardin¹, S. Girard¹, J.-E. Sauvestre¹, A. Bournel³;

¹CEA, DAM, DIF; ²ONERA; ³CNRS, Universite Paris-Sud

The relative contribution of the radial ionization profile on SEE prediction is investigated using MUSCA SEP3, in comparison with the classical approach considering the ion track as a series of punctual charges.

16:25 C-5 An Analytical Model of the Propagation Induced Pulse Broadening (PIPB) Effects on Single Event Transient in Flash-based FPGAs.

L. Sterpone¹, N. Battezzati¹, F. Kastensmidt²;

¹Politecnico di Torino; ²Universidade Federal do Rio Grande Do Sul

An analytical model for the characterization of PIPB effects concerning the SETs propagation within logic and routing resources of Flash-based FPGAs is developed. Experimental results comparing the model with electrical fault injection demonstrate its effectiveness.

16:40 C-6 Post SEGR and SEB Investigation of Device Parameters as Indicators of the Mechanisms in Power MOSFET Failure.

L. Scheick¹, L. Selva²

¹JPL/CIT; ²Consultant

Single Event Gate Rupture and Single Event Burnout mechanisms are investigated through analyzing device parameters after experiencing an event. Observed changes show strong correlation to event type, ion impact location, and site of damage.

Posters for Session C

PC-1 14 MeV Neutrons SEU Cross Sections in Deep Submicron Devices Calculated Using Heavy Ion SEU Cross Sections.

A. Haran, J. Barak, L. Weissman, D. David, E. Keren;

Soreq NRC

An analytical model is developed to calculate neutron induced SEU cross-section in deep submicron devices from heavy ion SEU cross-section. The model is applied to SEU from 14 MeV neutrons and compared with experimental results.

PC-2 Impact of Resistive-Open Defects on SRAM sensitivity to Soft Errors.

P. Rech¹, J.-M. Galliere¹, P. Girard¹, F. Wrobel², F. Saigne², L. Dilillo¹;

¹LIRMM Universite de Montpellier 2; ²IES Universite de Montpellier 2

We investigate resistive-open defect impact on SRAM radiation induced error rate through SPICE simulations. We show how it is important to consider dynamic test in order to estimate the correct SRAM radiation sensitivity.

PC-3 Comparison between single collection and multi collection on SEU induced by protons on nanometric SRAM cells.

G. Toure-Samb^{1,2}, G. Hubert¹, K. Castellani-Coulie², S. Duzellier¹, J.-M. Portal²;

¹ONERA ; ²IM2NP

This paper presents a new approach to study the multi collection in SRAM 90nm technology from Xilinx. It compares the relative influence of NMOS and P-MOS sensitive zones within the cell by SPICE simulations.

PC-4 Circuit effect on Collection Mechanisms involved in Single Event Phenomena: Application to the Response of a NMOS Transistor in a 90nm SRAM Cell.

K. Castellani-Coulié¹, G. Toure¹, J.-M. Portal¹, O. Ginez¹, H. Aziza¹, A. Lesea³;

¹IM2NP; ²ONERA; ³Xilinx

Different SEU simulation approaches are studied corresponding to “current collection”/“current injection”. It is shown that by not accounting for voltage variations induced in the circuit by the particle generation, “current injection” overestimates the current.

PC-5 Accurate Modeling of Single Event Transients in a SiGe Voltage Reference Circuit.

K. Moen¹, L. Najafizadeh¹, A. Raman², M. Turowski², J. Cressler¹;

¹Georgia Institute of Technology; ²CFD Research Corporation

Single event transients are modeled in a SiGe voltage reference using compact model and 3D mixed-mode TCAD simulations. These methods are benchmarked against measurements to assess their effectiveness in modeling SET in SiGe analog circuits.

Technical Programme – Tuesday, 21 September 2010

16:55 Session D: Photonics

Introduction by Chair: Maite Alvarez and Benoit Brichard



Maite Alvarez



Benoit Brichard

17:00 D-1 Dose rate and static/dynamic bias effects on CCDs.

E. Martin^{1,2}, J.-P. David¹, T. Nuns¹, O. Gilard², M. Boutillier², A. Penquer²;

¹ONERA; ²CNES

Dark current evolution in Co60-irradiated CCDs is studied in various static and dynamic bias conditions. Results have demonstrated the impact of the sensor operational conditions and dose rate. On-ground results are compared to in-flight data.

17:15 D-2 Simulations of High Energy Electron-Induced Transients in a Shielded Focal Plane Array.

E. Auden¹, R. Weller¹, M. Mendenhall¹, R. Reed, R. Schrimpf¹, M. King¹, N. Dodds¹, M. Asai²;

¹Vanderbilt University; ²SLAC

Monte Carlo simulations of a shielded focal plane array demonstrate energy deposition in individual pixels exceeding 0.1 MeV when 100 MeV electrons incident upon a 10 cm aluminum spherical shell produce electromagnetic cascades.

17:30 D-3 Comparison of the Radiation Sensitivity of Fiber Bragg Gratings made by Four Different Manufacturers.

S. Hoeffgen¹, H. Henschel¹, J. Kuhnhen¹, U. Weinand¹, C. Caucheteur², D. Grobnc³, S. Mihailov³;

¹Fraunhofer Institute; ²Faculte Polytechnique de Mons; ³Communication Research Center, Canada

The radiation sensitivity of type I FBGs written by four different manufacturers with different UV or IR lasers in two different Ge-doped H₂ loaded and unloaded fibers was investigated. The measured peak shifts agreed quite well.

Technical Programme – Tuesday, 21 September 2010

Posters for Session D

PD-1 Single Event Upset studies on a 0.20um FD-SOI monolithic pixel sensor.

S. Mattiazzo^{1,2}, M. Battaglia^{3,4}, D. Bisello^{1,2}, D. Contrarato⁴, P. Denes⁴, P. Giubilato^{1,2}, D. Pantano^{1,2}, N. Pozzobon^{3,4}, L. Silvestrin^{1,2}, M. Tessaro^{1,2}, J. Wyss^{2,5},

¹University of Padova; ²INFN; ³SCIPP, University of California Santa Cruz; ⁴Lawrence Berkeley National Laboratory; ⁵DiMSAT, Università degli Studi di Cassino

Monolithic Pixel Detectors on a Fully Depleted SOI technology are currently under development. A preliminary Single Event Upset measurement was performed on the last chip developed in a 0.20um technology, for different substrate depletion.

PD-2 Modelling neutron interactions and charge collection in the Imaging Single-Event Effects Monitor.

C. Xiao Xiao¹, S. Platt¹, S. Monk²;

¹University of Central Lancashire; ²University of Lancaster

An enhanced model of our Imaging Single-Event Effects Monitor (ISEEM) is described with validation against experimental data from irradiation in neutron beams. Quantified discrepancies between simulated and experimental results are close to measurement uncertainties.

17:45 End of the session

18:00 Welcome Reception at the Conference Hotel

Technical Programme – Wednesday, 22 September 2010

07:30 Registration

08:45 Session E: Space and Terrestrial Environments

Introduction by Chair: Sebastien Bourdarie and Richard Sharp



Sebastien Bourdarie



Richard Sharp

08:50 E-1 Cosmic-ray Heavy Ions Contribution to Radiation Effects in the Atmosphere.

F. Lei, A. Hands, P. Truscott, C. Dyer;

QinetiQ

Although heavy ions constitute only ~1% of the total cosmic ray flux, they can make a significant contribution to the radiation field in the upper atmosphere. This contribution is assessed by MC simulations within the QARM.

09:05 E-2 In flight measurements of radiation environment on board the French satellite JASON-2.

D. Boscher¹, S. Bourdarie¹, D. Falguere¹, D. Lazaro¹, P. Bourdoux², T. Baldran², G. Rolland³, E. Lorfevre³, R. Ecoffet³;

¹ONERA/DESP; ²EREMS; ³CNES

We present particle flux measurements (protons and electrons) obtained with the detector ICARE-NG on board the JASON-2 satellite (1350 km, 63°). Comparisons of measurements with the results of the AP8 model are given for protons.

09:20 E-3 JOSE: A new Jovian Specification Environment model.

A. Sicard-Piet¹, S. Bourdairie¹, N. Krupp², P. Truscott³, J. Sorensen⁴;

¹ONERA/DESP; ²Max Planck Institute; ³QinetiQ; ⁴ESA

This document presents a new Jovian Specification Environment model (JOSE), developed at ONERA, based on data measured in Jupiter's magnetosphere, in order to obtain an easy-to-use engineering model for Jupiter's environment.

Posters for Session E

PE-1 Geographic SEE Rate Predictions for the METOP Satellite.

H. Evans¹, E. Daly², G. Santin¹, S. Strijk³, F. Sturesson⁴;

¹Rhea Group, ESA/TEC-EES; ²ESA/TEC-EES; ³ESA/EOP-PLE; ⁴ESA/TEC-QEC

By considering geomagnetic shielding effectiveness and models of the trapped proton belt, the risk of upsets has been characterized for the METOP satellite. The SPENVIS software was modified to include GaAs components and the IGRF.

PE-2 FLUKA simulations for SEE Studies of Critical LHC Underground Areas.

K. Røed, M. Brugger, A. Ferrari, D. Kramer, E. Lebbos, R. Losito, G. Spezia;

CERN

FLUKA Monte Carlo simulations have been performed to identify particle energy spectra and fluences relevant for evaluating the risk of single event effects in electronics installed in critical LHC underground areas.

PE-3 Comparison between dose predictions and in-flight measurements on JASON-2 satellite.

P. F. Peyrard¹, O. Rony¹, A. Canals¹, R. Ecoffet², F. Bezerra², E. Lorfèvre²;

¹TRAD; ²CNES

The TRAD space dosimeters onboard of JASON2 give the possibility to compare the in-flight dose measurements with the predicted deposited doses using various methods and radiation modelling approaches.

09:35 End of the session

Technical Programme – Wednesday, 22 September 2010

09:35 Session F: Single Event Effect 2: Devices and Integrated Circuits

Introduction by Chair: Florent Miller and Raymond Ladbury



Florent Miller



Raymond Ladbury

09:40 F-1 Radiation Results from the ERNObox Flight Demonstrator Experiment.

S. Rakers, J. Schneegans, A. Schuettauf, T. Vogel;

Astrium Space Transportation GmbH

The paper presents the radiation properties and in-flight results of a novel LEON-2-FT based computer flown as demonstrator aboard the ISS for one year. The computer contains state-of-the-art components as Flash-FPGAs, SDRAM and MEMS devices.

09:55 F-2 SEE Test on DC and RF operated GaN X-Band Power HFET's.

M. Rostewitz¹, E. Jutzi¹, K. Hirche¹, N. Chaturvedi², J. Würfl²;

¹TESAT Spacecom; ²Ferdinand-Braun-Institut für Höchstfrequenztechnik

GaN X-band power HEMT have been heavy ion irradiated under static (DC) and RF operation, both CW and QPSK modulated. Test results shall be presented. Neither single event burn-out nor significant degradation occurred.

10:10 Coffee Break

10:40 F-3 Single Event Effects in Power MOSFETs and SRAMs due to 3 & 14 MeV Neutrons.

A. Hands, P. Morris, C. Dyer, K. Ryden;

QinetiQ

SRAMs and Power MOSFETs were exposed to 3 MeV and 14 MeV neutrons. We observed multiple cell upsets in 90 nm SRAMs and single event burnouts for the first time in Power MOSFETs at 3 MeV.

10:55 F-4 Impact of Switched Dose Rate Irradiation on LM124 Circuitry Response Phenomenon in Pulsed X-Ray Environment.

N. J.-H. Roche¹, L. Dusseau¹, J. Mekki¹, J.-R. Vaill^{1,2}, Y. Gonzalez Velo¹, S. Perez¹, J. Boch¹, F. Saigne¹, R. Marec³, P. Calvel³, F. Bezerra⁴, G. Auriel⁵, B. Azais⁶;

¹Universite Montpellier 2 - IES; ²Universite de Nimes; ³Thales Alenia Space ; ³CNES ; ⁴CEA; ⁵DGA

The Synergistic effect between TID and TREE in an op-amp is investigated. The impact of TID on TREE is found to be identical when the dose rate is low or switched from High to Low.

Technical Programme – Wednesday, 22 September 2010

11:10 F-5 Impact of Scaling on the Heavy-ion Upset Cross Section of Multi-Level Floating Gate Cells.

M. Bagatin¹, S. Gerardin¹, A. Paccagnella¹, G. Cellere², A. Visconti³;

¹DEI - University of Padova and with INFN; ²Applied Materials Baccini; ³Numonyx, R&D – Technology Development

We examine how feature size scaling affects the upset susceptibility of multi-level floating gate cells. Experimental data and modeling are used to study the threshold LET and saturation cross section dependence on the feature size.

11:25 F-6 Incremental Enhancement of SEU Hardened 90nm CMOS Memory Cell.

N. Haddad, A. Kelly, R. Lawrence, B. Li, J. Rodgers, J. Ross;

BAE Systems

An incremental SEU enhancement approach, utilizing selective enhancement features, was demonstrated on the same basic SRAM cell, allowing various SEU/performance trade-off to support multiple application space.

11:40 F-7 Digital SEE Characterization of 0.13- μ m Fusion Mixed-Signal Flash-Based FPGA.

S. Rezgui, J. Wang, R. Sharmin, D. D'Silva, J. McCollum;

ACTEL

Heavy-ions test results utilizing novel test methodologies of reprogrammable and non-volatile mixed-signal flash-based FPGAs are presented and discussed. The programmable architectures tested are the I/O structures, FPGA core, embedded flash memory blocks, and analogue block.

Posters for Session F

PF-1 A Single Event Effect Analysis on C2VSL Circuits with Gated Feedback.

H. Hatano;

Shizuoka Institute of Science and Technology

Clocked cascade voltage switch logic (C2VSL) circuits with gated feedback were newly designed. Single event transient (SET) effects on the C2VSL circuits were investigated using SPICE. SET tolerance was compared to conventional complex CMOS circuits.

PF-2 Enabling Performance versus Reliability Tradeoffs in Memories Using Block Parity.

P. Reviriego¹, C. Argyrides², A. Maestro¹, D. Pradhan³;

¹Universidad Antonio de Nebrija; ²C. A. evolUT; ³University of Bristol

We propose a technique to substantially improve the reliability of memories that use SEC-DED. We improve the Mean Time to Failure of the memory at the cost of increasing the access time for writing operations.

PF-3 Influence of the Bias Conditions on the Single Event Transients of the LM311 Voltage Comparator.

*I. Lopez-Calle, F. J. Franco, J. G. Izquierdo, J. A. Agapito;
Universidad Complutense de Madrid*

Laser experiments on the LM311 comparator were performed in order to investigate the influence of configuration parameters such as the pull-up resistor or the power supplies on the shape of the single event transients.

PF-4 Micro SEL Studies in COTS SRAM Devices by Laser Backside Testing.

G. Feng¹, S. Shangguan², Y. Ma², J. Han¹, Z. Zhang¹;

*¹Center for Space Science and Applied Research, Chinese Academy of Sciences;
²Graudate University of Chinese Academy of Sciences*

This summary presents micro single event latch-up (SEL) characterization of commercial-off-the-shelf (COTS) SRAM Devices by laser backside testing method, which is dedicated to cope with the increasing metal layers on the front side of the Integrated Circuits.

PF-5 Application-oriented SEU cross-section of a processor soft core for Atmel RHBD FPGAs.

N. Battezzati¹, F. Margaglia¹, M. Violante¹, F. Decuzzi², D. Merodio Codinachs², B. Bancelin³;

¹Politecnico di Torino; ²ESA; ³ATMEL

Approximating SEU sensitiveness by the device cross-section for applications implemented in FPGAs is very pessimistic. We propose and validate a static analysis approach to assess the application-oriented cross-section, providing evidence on a soft processor.

PF-6 Non-Intrusive Hybrid Signature-Based Technique to Detect SEU and SET Faults in Microprocessors.

*J. R. Azambuja, F. Sousa, L. Rosa, F. Kastensmidt;
Universidade Federal do Rio Grande do Sul*

This paper presents a hybrid technique based on software signatures and watchdog processors to detect SEU and SET faults in microprocessors. A light watchdog is implemented. Results show high detection rates and small performance degradation.

11:55 Lunch

Technical Programme – Wednesday, 22 September 2010

13:25 Invited talk

New Insights into the Life and Death of the Tyrolean Iceman

by Albert Zink



Albert Zink received his PhD (1998) at the University of Munich, where he also finished his habilitation (Assistant Professor) in 2005. At present he is director of the Institute for Mummies and the Iceman in Bolzano, Italy. He is responsible for the scientific investigation of the well-known Tyrolean Iceman. Moreover, the Institute is planning and performing studies on mummy collection from different parts of the world, including Egypt, South Korea, South America and Europe. Albert Zink is specialized in the molecular detection of infectious diseases in ancient human skeletons and mummies by using ancient DNA technologies. His major scientific interest is the evolution of infectious diseases and the impact of diseases on historic populations and their development.

The Tyrolean Iceman, commonly known as Ötzi, is one of the world most famous mummies. He was found in 1991 in the Alps and died c. 5300 years ago. A lot of scientific studies have been performed and fascinating results have been obtained, such as the arrowhead that killed him and still is inside his body. It is well known that he grew up and lived at the Southern side of the Alps that he was well trained and used to walk around in the Alpine environment. Within the last years the Institute for Mummies and the Iceman has contributed significantly to a better understanding of the last days of the Iceman and the circumstances that have led to his death in the Alps. The latest findings deriving from morphological, radiological and nanotechnological investigations will be presented that allow new insights into the life and violent death of the Iceman.

14:25 Radiation Effects Data Workshop

Introduction by Chair: Christian Poivey and Nick Van Vonno



Christian Poivey



Nick Van Vonno

DW-1 Single Event Effect Test Results for Candidate Spacecraft Electronics.

Q. Yu¹, M. Tang¹, D. Zhang¹, M. Meng¹, Y. Zhang¹, H. Zhang¹, X. Qi¹, P. Li¹, C. Huang¹, G. Guo², J. Liu³;

¹China Academy of Space Technology; ²China Institute of Atomic Energy; ³Institute of Modern Physics, Chinese Academy of Sciences

Heavy ion tests were performed to study the Single Event Effect (SEE) on emerging technology devices, including CMOS image sensor, ferroelectric memory, signal processor and microprocessor. Characteristic data of Single Event Upset (SEU) and Single Event Latch-up.

DW-2 Total Dose Testing of the ISL70001SRH Hardened Point of Load Regulator.

*N. van Vonno, L. Pearce, J. Gill, B. Satterfield, E. Thomson, A. Williams, P. Chesley;
Intersil*

We report the results of total dose testing at low and high dose rate of the ISL70001RH hardened POL regulator and discuss part design, performance and applications. The part is implemented in submicron BiCMOS.

DW-3 Low Dose Rate Testing of Legacy Intersil Products.

*N. van Vonno, L. Pearce, E. Thomson, P. Chesley, J. Gill;
Intersil*

We report the results of low and high dose rate ^{60}Co testing of a total of eleven Intersil parts, including dielectrically isolated and junction isolated types. The MIL-STD-883 procedure for ELDRS sensitivity determination was used.

DW-4 Compendium of TID and SEE Test Results for Various Candidate Spacecraft Electronics.

*F. Malou¹, D. Dangla¹, C. Boatella-Polo¹, A. Rousset², F.-X. Guerre;
¹CNES; ²TRAD; ³HIREX*

We present data on the vulnerability of various candidate spacecraft electronics to total ionizing dose and heavy ion induced single event effects. Most of the tested devices are commercial integrated circuits, including Analog-to-Digital Converters, Memories products and others.

DW-5 Proton Radiation Test Results of Candidate Spacecraft Electronic devices for a Low-Earth Orbit Micro-satellite.

*E. Gloutnay, N. Valsecchi, J.-F. Cusson, S. Lafrance, J. Hardy, T. Pellerin, L. Forest,
H. P. Ly, G. Brassard;
CSA*

This paper reports the results of Single Event Effect (SEE) testing of commercial microelectronic devices after exposure to protons. These devices were being evaluated for a microsatellite application. Test protocol, results and analysis are discussed.

DW-6 TID Characterization of Rad-Hardened Bipolar Transistors Prototypes.

*G. Chaumont, A. Uguen, A. Nehdi, P. Briand;
STMicroelectronics*

Bipolar transistors prototypes have been TID characterized at two different low dose rates until 100krad(Si) and 300krad(Si) respectively. This paper presents the TID data at both dose rates and compares the results with standard products.

DW-7 ELDRS: Dynamic vs. Static dose rate testing.

*A. Keating, A. Zadeh, M. Muschitiello, B. Nickson;
ESA*

Dynamic and static TID irradiation tests on bipolar based ICs were performed to investigate the ELDRS Radiation Hardness Assurance processes.

DW-8 Characterization of CMOS Devices for a Very High Dose Mission.

*R. Harris, S. McClure, B. Rax, A. Kenna, D. Thornbourn, K. Clark, T.-Y. Yan;
NASA/JPL*

CMOS devices have been evaluated for doses up to 1 Mrad. All of the parts evaluated to date show functional, extreme parametric, or mild parametric failure long before the 1 Mrad dose is reached.

DW-9 ATMEL ATF280 Radiation Hardened SRAM Based reprogrammable FPGA.

*G. Mantelet, M. Briet, G. Rouxel, S. Hachad;
ATMEL*

The paper presents the ATMEL rad-hard SRAM based reprogrammable FPGA design choices as well as the Single Event Effect test results to illustrate the capability of this product to be used in space.

DW-10 SEE Test Results of National Semiconductor's LVDS Driver and Receiver Pair DS90C031 and DS90C032.

*K. Kruckmeyer, T. Santiago, R. Eddy;
National Semiconductor*

Updated Single Event Latchup, Functional Interrupt and Upset data are presented for National Semiconductor's Low Voltage Differential Signal Driver and Receiver pair, DS90C031WxRQMLV and DS90C032WxLQMLV.

DW-11 Proton and Heavy Ion induced SEL in a Xilinx XC95108 CPLD.

*T. Wijnands¹, Q. King¹, B. Todd¹, F.-X. Guerre²;
¹CERN; ²HIREX*

A study of Single Event Latch Ups (SELs) in a XC95144 (CPLD) device is presented using protons at 60 MeV and 230 MeV and low and high penetrating ions with LETs ranging from 3 to 34 MeVcm²/mg.

Technical Programme – Wednesday, 22 September 2010

DW-12 Space degradation of solar cells at low temperatures.

S. Makham, G. Sun, J. Bourgoïn;

GESEC R&D

The technique used to monitor the electrical characteristics of solar cells versus irradiation fluence in the range 80 – 300 K is described and then illustrated by results obtained for GaAs, GaInP and triple junction GaInP/GaAs/Ge cells.

DW-13 Results of Single-Event Latchup Measurements Conducted by the Jet Propulsion Laboratory.

F. Irom, T. Miyahir;

NASA/JPL

This paper reports recent single-event latchup (SEL) results for a variety of microelectronic devices that include OpAmp, Voltage Reference, Motor Controller, Switch Mode Controller, Resolver-to-Digital Converter and Analog-to-Digital Converter.

DW-14 Radiation effects in the PowerPC7448 Microprocessor.

D. Lambert¹, X. Vega¹, D. Alexandrescu², B. Azais³;

¹EADS; ²iRoC Technologies; ³DGA

Total Ionizing Dose and upset susceptibility are measured for the PowerPC MPC7448 microprocessor. SEE cross-sections for protons and neutrons have been tested for registers and data caches. Main characteristics of susceptibility are given.

16:00 End of the session

16:30 Departure for Tyrol Evening

Technical Programme – Thursday, 23 September 2010

07:30 Registration

08:45 Session G: Radiation Hardness Assurance

Introduction by Chair: Stephen Buchner and Ali Mohammadzadeh



Stephen Buchner



Ali Mohammadzadeh

08:50 G-1 SEU Analysis of Complex Circuits Implemented in Actel RTAX-S FPGA Devices.

M. Berg¹, M. Friendlich¹, C. Perez¹, H. Kim¹, C. Seidleck¹, K. LaBe²;

¹MEI Technologies; ²NASA GSFC

A novel approach to SEE characterization of counters implemented in a RTAX-s FPGA is presented. Net fan-out, capacitive loading, and operational frequency have demonstrated a direct impact to counter SEU cross sections as compared to shift registers.

09:05 G-2 Analysis of Low Dose Rate Effects on Parasitic Bipolar Structures in CMOS Processes for Mixed-Signal Integrated Circuits.

K. Kruckmeyer, J. Prater, B. Brown, T. Trinh;

National Semiconductor

The effect of different radiation dose rates on parasitic bipolar structures in CMOS processes is evaluated on three mixed-signal products (2 ADCs and 1 DAC) and the MIL-STD-883 room temperature anneal test method is validated.

09:20 G-3 Experimental Demonstration of Pattern Influence on DRAM SEU & SEFI Radiation Sensitivities.

A. Bougerol¹, F. Miller¹, N. Guibbaud², R. Leveugle³, T. Carriere⁴, N. Buard¹;

¹EADS; ²APTUS; ³TIMA Laboratory; ⁴Astrium Space Transportation

This paper investigates the pattern influence regarding SEU and SEFI radiation sensitivities in a 90nm DDR memory. Thanks to laser and heavy ion tests, it is demonstrated that random pattern is the most appropriate.

Technical Programme – Thursday, 23 September 2010

09:35 G-4 Single Event Test Methodologies and System Error Rate Analysis for Triple Modular Redundant Field Programmable Gate Arrays.

G. Allen¹, L. Edmonds¹, G. Swift², C. Carmichael², W. Tseng², K. Heldt³, S. Anderson³, M. Coe³;

¹JPL/California Institute of Technology; ²Xilinx, Inc.; ³SEAKR Engineering

We present a test methodology for estimating system error rates of Field Programmable Gate Arrays mitigated with Triple Modular Redundancy. The test methodology is founded in a mathematical model and compared with accelerator data.

09:50 G-5 Significance of Worst-Case Test Vectors for Logic Faults Induced in ASICs by Total Dose.

A. Abou-Auf¹, H. Abdel-Aziz¹, A. Wassal²;

¹The American University in Cairo; ²Cairo University

We developed a methodology for worst-case test vectors (WCTV) in CMOS ASICs using fault models extended to processes with field oxide leakage. We validated the significance of using WCTV in total-dose testing.

Posters for Session G

PG-1 Sensitivity Evaluation Method for Aerospace Digital Systems with Collaborative Hardening.

M. Portela-Garcia¹, C. Lopez-Ongil¹, M. Garcia-Valderas¹, L. Entrena¹, A. Martin-Ortega², J. R. Mingo², S. Rodriguez²;

¹Carlos III University of Madrid; ²National Institute of Aeronautics and Space

In this paper, we propose a new method for evaluating the radiation sensitivity of aerospace digital systems composed of complex programmable devices, with hardware functionality distribution and collaborative hardening.

PG-2 Quantitative Enhanced Low Dose Rate Sensitivity Model Parameter Extraction.

G. Zebrev¹, R. Useinov², A. Kuzovlev¹, I. Gorbachev¹, V. Anashin³;

¹MEPhI – National Research Nuclear University; ²Research Institute of Scientific Instruments; ³Research Institute of Space Instrument Engineering

Based on literature data for irradiation of bipolar devices at different temperatures the extraction of the quantitative ELDRS model parameters is performed. Two types of defects responsible for NPN and PNP device degradation have found.

PG-3 The software complex for SEU rate and radiation dose calculation.

V. S. Anashin¹, V. V. Emeliyanov², I. O. Ishutin¹, N. V. Kuznetsov³, G. A. Protopopov¹, G. I. Zebrev⁴

¹Institute of Space Device Engineering; ²V. Tikhomirov Scientific Research Institute of Instrument Design; ³Skobeltsyn Institute of Nuclear Physics; ⁴MEPhI – National Research Nuclear University

A new software complex, allowing to calculate the radiation dose and SEU rate is presented. The results of verification and flight data comparisons are considered in the paper.

Technical Programme – Thursday, 23 September 2010

10:05 Coffee Break

10:35 Session H: Technology and Design Hardening

Introduction by Chair: Hugh Barnaby and Philippe Paillet



Hugh Barnaby



Philippe Paillet

10:40 H-1 A Novel Co-Design Approach for Soft Errors Mitigation in Embedded Systems.
F. Restrepo-Calle¹, A. Martinez-Alvarez¹, F. R. Palomo², H. Guzman-Miranda², M. A. Aguirre², S. Cuenca-Asensi¹;

¹University of Alicante; ²University of Sevilla

A novel proposal to design radiation-tolerant embedded systems combining hardware and software mitigation techniques is presented. Two suites of tools are developed to automatically apply the techniques and to facilitate the trade-offs analyses.

10:55 H-2 FPGA fault tolerance in radiation susceptible environments.

J. Gebelein, H. Engel, U. Kebschull;

Heidelberg University, Kirchhoff-Institute for Physics

This paper deals with approach and initial construction of an FPGA-based fault-tolerant bottom-up architecture for Programmable Embedded Systems on Chip, spanning all layers of modern hardware as well as software architecture.

11:10 H-3 Improved Radiation Hardness-By-Design Library for 0.15um Fully Depleted SOI-ASIC.

A. Makihara¹, T. Ebihara¹, T. Yokose¹, Y. Tsuchiya¹, Y. Miyazaki¹, A. Maru², H. Shindou², S. Kuboyama²;

¹HIREC; ²JAXA

This paper describes TID and SEU/SET test results on the improved Radiation-Hardness-By-Design Library for 0.15um Fully Depleted CMOS/SOI-ASIC fabricated by a commercial foundry. Sufficient immunity was demonstrated for TID and SEU/SET required for space applications.

Technical Programme – Thursday, 23 September 2010

11:25 H-4 **Phase-Dependent Single-Event Sensitivity Analysis of High-Speed A/MS Circuits Extracted from Asynchronous Measurements.**

S. Armstrong^{1,2}, D. T. Loveless², J. Hicks², D. McMorro², L. Massengill²;

¹NAVSEA Crane; ²Vanderbilt University;

A simplified method for experimental determination of the phase dependence of single-event sensitivity of gigahertz A/MS circuits is presented. The technique uses asynchronous time-based data collection, enabling determination of circuit acceptability for space system usage.

11:40 H-5 **An Efficient Technique to Select Logic Nodes for Single Event Transient Pulse-Width Reduction.**

*N. Mahatme, I. Chatterjee, A. Patki, D. Limbrick, R. Schrimpf, B. Bhuvu, W. Robinson;
Vanderbilt University*

This paper introduces an efficient method to identify logic nodes most likely to generate single-event transients. Selected nodes are hardened by gate resizing. This is integrated with temporal masking to increase fault tolerance.

Posters for Session H

PH-1 **Double Modular Redundancy for Single Event Upset Mitigation.**

F. Smith¹, A. Barnard²;

¹Nelson Mandela Metropolitan University; ²Stellenbosch University

A Double Modular Redundancy approach for mitigating SEUs in sequential circuits is provided which requires less power and surface area than TMR solutions but which facilitates substantial immunity of the electronic circuits against SEUs.

PH-2 **A Fault Tolerant Adaptive Equalizer implemented with Reconfigurable SRAM-based FPGAs.**

S.-F. Liu¹, G. Sorrenti², P. Reviriego¹, F. Casini^{2,3}, J. A. Maestro¹, Monica Alderighi³;

¹Universidad Antonio de Nebrija; ²Sanitas EG s.r.l.; ³Istituto Nazionale di Astrofisica, Istituto di Astrofisica Spaziale e Fisica Cosmica

This paper proposes novel system-level protection techniques for feed forward equalizers, which exploit application and system knowledge, resulting in a more intelligent protection with a 71% saving of circuit complexity in comparison to XTMR.

PH-3 **Analysis of SET effects in a PIC microprocessor for selective hardening.**

L. Entrena, A. Lindoso, M. García Valderas, M. Portela, C. López Ongil;

Carlos III University

A method to evaluate the criticality of each gate in a circuit with respect to SET effects for selective application of mitigation techniques with reduced overheads.

Technical Programme – Thursday, 23 September 2010

PH-4 A Hardened-by-Design Bias Circuit Utilizing Multi-Node Charge Collection at Sub-100 nm Technology Nodes.

*R. Blaine, B. Olson, S. Armstrong, W. T. Holman, J. Kauppila, L. Massengill;
Vanderbilt University;*

A novel RHBD technique is described that utilizes charge sharing to mitigate voltage transients due to single event strikes in a bias circuit. The technique is verified using simulations in a 90-nm CMOS process.

11:55 Lunch

13:25 Invited talk

Radiation Damage: Particle Interactions in Nanometre-sized Volumes, a Challenge for Radiation Physics and Life Science.

by Bernd Großwendt.



Bernd Großwendt; PhD in Physics, guest professor at AIT Austrian Institute of Technology, and Director and Professor_{A.D.} at Physikalisch-Technische Bundesanstalt (PTB), Germany which is the leading metrology institute of Europe, particularly, in the field of radiation dosimetry. There, he worked as the head of department 'Fundamentals of Dosimetry' which is devoted to the physics of particle interactions, to atomic physics, and to the physics of radiation transport in matter, mainly, in view of radiation dosimetry for purposes of radiation therapy, radiation protection, and radiobiology. He is author of several Monte Carlo codes and author or co-author of more than 180 publications in international scientific journals. His current research interests are focused on particle track structure and on nanodosimetry in particular.

Radiation-induced damage to living cells or genes is governed, to the greater part, by the pattern of inelastic interactions of ionizing particles in sub-cellular targets (segments of the DNA, nucleosomes, and segments of the chromosome fibre). In consequence, the effectiveness and quality of ionizing radiation should be defined more in terms of quantities which are directly related to the track structure of ionizing radiation than in terms of macroscopic quantities like absorbed dose and linear energy transfer (*LET*). To tackle this challenge for radiation metrology, a track-structure based concept of radiation damage has been developed assuming that the initial damage to nanometre-sized volumes like the DNA is mainly due to the number of ionizing processes of single particles within a target volume or in its near neighbourhood. This number of particle interactions (the so-called cluster size) serves as a measure of the degree of radiation damage, and the cluster-size frequency as a measure of the radiation-induced damage probability. Radiation damage is described, therefore, in terms of particle interaction probabilities in nanometric volumes (nanodosimetry), and the traditional description of radiation damage in terms of *LET* and absorbed dose is exchanged by a probabilistic description of cluster-size formation which characterizes the interaction pattern of ionizing radiation and, thus, the particles' track structure. The same concept should also be applied to describe the radiation damage to complex structures other than those of living cells such as complex systems of electronic circuits if the sizes of the radiation sensitive components of the system are of the order of a few nanometres.

Technical Programme – Thursday, 23 September 2010

14:25 Posters and Late News

Introduction by Chair: Philippe Adell and Antoine Touboul



Philippe Adell



Antoine Touboul

LN-1 Assessment of Shielding Strategies, Dose Enhancement Effects and Shielding Tools for MEO and Jovian Missions.

P. Truscott¹, K. Ford¹, S. Rason², F. Lei¹, D. Heynderickx³;

¹QinetiQ; ²Surrey Satellite Technology Ltd; ³DH Consultancy

The performance of low- and high-Z shielding, as well as graded shields, is compared for Galileo-GPS and Jovian mission environments. As well as MULASSIS/Geant4, an updated version of SHIELDOSE-2 is used for 1D shielding analysis.

LN-2 Radiation effects in ytterbium-doped silica optical fibers: traps and color centers related to the radiation-induced optical losses.

F. Mady, M. Benabdesselam, Y. Mebrouk, B. Dussardier;

LPMC CNRS University of Nice-Sophia Antipolis

This work establishes connections between radiation-induced optical absorption and hole trap filling in ytterbium-doped optical fibers. It sets basic hardening routes to develop high output power Yb-doped fiber lasers for inter-satellite optical links eventually.

LN-3 TID-induced degradation in static and noise behavior of sub-100 nm multifinger bulk NMOSFETs.

L. Ratti^{1,2}, L. Gaioni², M. Manghisoni^{2,3}, V. Re^{2,3}, G. Traversi^{2,3};

¹Universita di Pavia; ²INFN, Pavia; ³Universita di Bergamo

Results from the total ionizing dose characterization of sub-100 nm NMOSFETs are used to provide further evidence for a static and noise degradation model involving charge buildup in shallow trench isolations and lateral parasitic transistor.

LN-4 Irradiation Test Procedure for IAEA Safeguards Instrumentation.

A. Chlenov¹, R. Ikhsanov¹, C. Liguori², C. Martinez², V. Kravtchenko², V. Ulimov¹, B. Wishard², V. Zinchenko¹;

¹Research Institute of Scientific Instruments; ²IAEA;

An IAEA irradiation testing procedure for nuclear safeguards instrumentation is discussed. This shall define the methodology and criteria to allow for the prediction of an instrument's reliability based on the results of a few samples.

LN-5 Dose Induce Breakdown in Lateral DMOS Devices.

P. Fernandez-Martinez¹, F. Palomo², I. Cortes¹, S. Hidalgo¹, D. Flores¹;

¹IMB-CNM-CSIC; ²Dpt. Ingenieria Electronica: University of Sevilla

LDMOS transistor can undergo a premature Dose Induced Breakdown (DIB) under ionizing irradiation conditions. The main post-irradiation effects responsible for de DIB effect on LDMOS devices are studied with the aid of physics-based TCAD simulations.

LN-6 First In-flight Data Analysis of Displacement Damages on the OSL Sensor On-board CARMEN-2.

C. Deneau¹, J.-R. Vaillé^{1,2}, L. Dusseau¹, J. Mekki¹, P. Garcia³, D. Boscher⁴, F. Bezerra⁵, E. Lorfèvre⁵, R. Ecoffet⁵;

¹IES - Université Montpellier 2; ²Universite de Nimes; ³TRAD; ⁴ONERA; ⁵CNES

The ability to monitor the displacement damage dose using the OSL sensor is demonstrated. A comparison between in-flight measurement on CARMEN-2 and ground based tests is led. The influence of the temperature is corrected.

LN-7 Experimental Characterization of Atmospheric Radiation Environment with Stratospheric Balloon.

F. Wrobel¹, J.-R. Vaillé^{1,2}, D. Pantel¹, L. Dilillo³, P. Rech³, J.-M. Galliere³, A. Touboul¹, P. Chadoutaud⁴, P. Cocquerez⁴, M. Lacourty⁴, T. Lam-Trong⁴, J.-L. Autran⁵, C. Chatry⁶, F. Laplanche⁷, B. Azais⁷; F. Saigne¹;

¹Université Montpellier 2 – IES; ²Universite de Nimes; ³Université Montpellier 2 – LIRMM; ⁴CNES ; ⁵Université Aix-Marseille and CNRS; ⁶TRAD ; ⁷DGA

We report a stratospheric flight with a CNES balloon for which we developed a silicon detector in order to obtain data on the atmospheric radiation environment. Experiments and simulations are in good agreement.

LN-8 Layout Technique for Single-Event Transient Mitigation via Pulse Quenching.

N. Atkinson, A. Witulski, W. Holman, J. Ahlbin, B. Bhuvu, L. Massengill;

Vanderbilt University

A recently developed layout technique that exploits single-event transient pulse quenching to mitigate transients in combinational logic is presented. TCAD simulations demonstrate how sensitive area and pulse width are reduced using this technique.

LN-9 The Technology Demonstration Module On-Board PROBA-II.

R. Harboe-Sorensen¹, N. Fleurinck², K. Puimege², C. Poivey¹, F.-X. Guerre³, F. Lochon³, M. Kaddour³, L. Li⁴, D. Walter⁴, A. Keating¹, A. Jaksic⁵, M. Poizat¹

¹RHS Consult; ²Verhaert Space; ³Hirex Engineering, ⁴IDA TU Braunschweig; ⁵Tyndall National Institute

As a semiconductor component radiation effects and technology demonstration experiment, the TDM on-board the PROBA-II satellite, will be described and some of its main features highlighted based on ground testing and calibrations.

Technical Programme – Thursday, 23 September 2010

LN-10 Laser validation of a non destructive test methodology for the radiation sensitivity assessment of power devices.

F. Miller¹, S. Morand¹, R. Gaillard³, T. Carrière², N. Buard¹;

¹EADS France; ²Astrium Space Transportation, ³Consultant

This paper presents a new test methodology based on the characterization of precursory events to perform non destructive radiation sensitivity assessment of power devices. Laser tests are used to demonstrate its efficiency.

LN-11 Neutron- and Proton-Induced SEU Error Rates for D- and DICE-Flip/Flop Designs at a 40 nm Technology Node.

D. Loveless¹, S. Jagannathan², T. Reece², J. Chetia², B. Bhuvu², M. McCurdy¹, L. Massengill², S.-J. Wen³, R. Wong³, D. Rennie⁴;

¹Institute for Space and Defense Electronics, Vanderbilt University; ²Department of Electrical Engineering and Computer Science, Vanderbilt University; ³Cisco Systems, Inc.; ⁴CertiChips, Inc.

Neutron and proton testing of 40 nm D- and DICE-Flip/Flop designs show small difference in error rates. Simulations are used to show that charge sharing is the primary cause for the increase in vulnerability.

LN-12 Total Dose Degradation of Voltage Regulators.

A. Johnston, B. Rax;

NASA/JPL

Total dose degradation is studied for low-dropout and conventional voltage regulators. Key parameters are identified, and circuit analyses are used to explain differences in degradation behavior. Internal bandgap reference performance is compared with conventional references.

LN-13 Evaluation Study of the Accelerated ELDRS Switching Test Method

M. Wind¹, P. Beck¹, J. Boch², L. Dusseau², A. Mohammadzadeh³, M. Poizat³;

¹AIT - Austrian Institute of Technology; ²University of Montpellier 2; ³ESA

We describe the set-up of an evaluation study to review the applicability of the accelerated ELDRS switching test method, that makes use of sequenced high and low dose rate exposures, to many electric device parameters of a comprehensive set of bipolar parts.

16:25 End of the session

16:30 RADECS General Assembly

18:00 End of the RADECS General Assembly

19:30 Gala Dinner

Technical Programme – Friday, 24 September 2010

08:30 Invited talk

Looking for the future after twenty years of RADECS

by Jean J. Gasiot



Jean Gasiot is Professeur Emérite at the University of Montpellier. Specialist in Radiation Physics, Docteur d'Etat since 1967, part of his work in the last decade has been concerned by the reliability of electronic devices and systems in space and nuclear applications. Jean Gasiot has developed in Montpellier a group dedicated to the study of radiation effects on materials and devices, with a special emphasis to the survey of basic mechanisms, the development of device modeling, and hardening. Jean Gasiot is the former President of the RADECS (Radiation and its Effects on Components and Systems) Association, and member of various scientific associations.

The “RADECS Association” activity has been dedicated for more than twenty years to cover the topic of radiation effects on materials, components and systems. The drastic evolution of electronic devices and the constant extension of the applications concerned support the interest for this area and will ensure the future activity. RADECS evolution is sustained by the search for excellence, openness, and dedication to serve a community.

09:30 Presentation of Thematic Workshops

Summary presentation by the Thematic Workshop Chairs.

10:30 Coffee Break

10:50 Session I: Ground Level Effects

Introduction by Chair: Werner Magnes and Frederic Wrobel



Werner Magnes



Frederic Wrobel

10:55 I-1 Alpha-Particle Induced Soft-Error Rate in CMOS 130nm SRAM.

S. Martinie¹, J.-L. Autran¹, S. Uznanski², P. Roche², G. Gasiot², D. Munteanu¹, S. Sauze¹, P. Loaiza³, G. Warot³, M. Zampaolo³;

¹IM2NP-CNRS; ²STMicroelectronics; ³LSM CEA-CNRS

We report the simulation of the alpha-SER in 130nm SRAM due to uranium contamination at ppb concentration levels. Monte-Carlo simulations are confronted to experimental data obtained from more than two years real-time underground measurements.

Technical Programme – Friday, 24 September 2010

11:10 I-2 Alpha-Particle and Focused-Ion-Beam-Induced Single-Event Transient Measurements in a Bulk CMOS 65-nm Technology.

M. Gadlage¹, J. Ahlbin², B. Bhuvu², N. Hooten², N. Dodds², R. Reed², L. Massengill², R. Schrimpf², G. Vizkelethy³;

¹NAVSEA Crane; ²Vanderbilt University; ³Sandia National Labs

Pulse widths of single-event transients produced by alpha particles are measured. The results show that alpha particles are able to induce transient signals with a width of 25 ps in a 65-nm bulk technology.

11:25 I-3 Uranium and Thorium Contributions to Soft Error Rate.

M. Gedion, F. Wrobel, F. Saigne;

IES - Université Montpellier 2

Uranium and thorium decay chains contribution to alpha particle-induced SER is evaluated on a 65 nm technology node by performing Monte Carlo simulations.

Posters for Session I

PI-1 Research of Radiation Effects in Aviation Altitudes During the Last Solar Cycle.

M. Latocha, P. Beck;

AIT – Austrian Institute of Technology

Cosmic radiation was discovered in the beginning of the XX century. This paper presents an overview of important findings on radiation effect in aviation altitudes during the last solar cycle.

11:40 End of the session

Technical Programme – Friday, 24 September 2010

11:40 Session J: Dosimetry and Facility

Introduction by Chair: Federico Ravotti and Jean-Roch Vaille



Federico Ravotti

Jean-Roch Vaille

11:45 J-1 **The use of a scanning electron microscope with electron beam lithography capability as a micro-beam irradiator.**

Y. Gonzalez Velo¹, J. Boch¹, F. Pichot², J. Mekki¹, N. J-H. Roche¹, S. Perez¹, C. Deneau¹, F. Saigne¹, L. Dusseau¹, E. Lorfevre³;

¹Universite Montpellier 2, IES; ²Universite Montpellier 2, CTM; ³CNES

A novel facility and technique is presented to realize controlled localized irradiation on ICs. Study of dose sensitivity of particular devices or circuit elements is enabled with this tool.

12:00 J-2 **The effect of magnetic field on diodes used as NIEL counters.**

I. Mandic¹, F. Ravotti², M. Glaser², J. Hartert³, S. Franz², I. Sersa¹, V. Cindro¹, I. Dolenc¹, A. Gorisek¹, G. Kramberger¹, M. Mikuz^{1,4};

¹Jozef Stefan Institute; ²CERN; ³Physikalisches Institut Universität Freiburg;

⁴Univeristy of Ljubljana

Diodes used as NIEL counters in high energy physics experiments operate in strong magnetic field which influences their performance. Measurements of magnetic field effects on these diodes before and after irradiation are presented.

12:15 J-3 **LHC RadMon SRAM detectors used at different voltages to determine the thermal neutron to high energy hadron fluence ratio.**

D. Kramer¹, M. Brugger¹, V. Klupak², C. Pignard¹, K. Roed¹, G. Spiezia¹, L. Viererbl², T. Wijnands¹;

¹CERN; ²NRI

Thermal neutron SEU cross-section of the RadMon detector's SRAM memory was measured at different voltages. A method profiting from the difference in response compared to high energy hadrons is proposed and tested in mixed fields.

Technical Programme – Friday, 24 September 2010

Posters for Session J

PJ-1 Dose measurements and Geant4 calculations on PMOS dosimeters manufactured with different oxide thicknesses and gate metals.

A. Canals¹, P. Pourrouquet¹, C. Chatry¹, B. Azais², P. Charre², G. Aurie², G. Sarabayrouse³;

¹TRAD; ²Centre d'étude de Gramat, DGA; ³LAAS-CNRS and Toulouse University

Twelve types of MOSFET dosimeters have been manufactured: four different oxides thickness ranging from 0.5µm to 2.4µm, were combined with three gate metals. They have been tested under several energy irradiation configurations.

PJ-2 Extended Bonner spheres for characterising neutron fields for single-event effects testing.

C. Xiaoxiao¹, S. Platt¹, S. Monk²;

¹University of Central Lancashire; ²University of Lancaster

We show how an extended Bonner sphere can be optimised for use as a proxy for devices subject to neutron-induced SEE. Such a detector can be used to characterise neutron fields for SEE testing.

PJ-3 Comparison of a Tissue Equivalent and a Silicon Equivalent Proportional Counter Microdosimeter to High-Energy Protons During a Simulated Solar Particle Event.

B. Gersey, R. Wilkins;

NASA Center for Radiation Engineering and Science for Space Exploration

Tissue equivalent and silicon equivalent proportional counter microdosimeters were exposed to protons ranging in energy from 30-160 MeV during a simulated solar particle event. Cumulative absorbed dose was 23% higher for the silicon microdosimeter.

12:30 End of the session

12:30 Conference Closing

13:00 Lunch

Awards

RADECS 2010 AWARDS

An Award committee will overview the scientific and technical output of the conference in order to elect the best Oral, Poster, and Data Workshop contribution from RADECS 2010.

Chair: Ronald Schrimpf and Marie C. Palau



Ronald Schrimpf

Marie C. Palau

RADECS 2009 AWARDS

A ceremony will be organized during the Gala Dinner to award outstanding works from the RADECS 2009.

Best Oral Presentation

Modeling of Ionizing Radiation-Induced Degradation in Multiple Gate Field Effect Transistors

I.S. Esqueda¹, H.J. Barnaby¹, F.E. Mamouni², R.D. Schrimpf²;

¹Arizona University; ²Vanderbilt University

Best Poster Paper

An Approach to Single Event Testing of SDRAMs

P.C. Adell¹, L. Edmonds¹, R. McPeak², L. Scheick¹, S.S. McClure¹;

¹Jet Propulsion Laboratory; ²Consultant

Best Data Workshop Paper

Low Dose Rate Test Results of National Semiconductors ELDRS-free Bipolar Comparators LM111 and LM119

K. Kruckmeyer, L. McGee, B. Brown, L. Miller

National Semiconductor

In addition the **Jean Marie Palau Prize** was created to award outstanding contributions from dedicated students. This Award will be given to the students during the closure ceremony of the conference on Friday.

Industrial Exhibition – 20-23 September 2010

Industrial Exhibition

Chair: Teresa Farris and Christian Chatry



Teresa Farris



Christian Chatry

The 2010 RADECS Exhibit Chairs welcome you to Längenfeld. As a RADECS attendee, we have scheduled the breaks so that you have the time to visit the companies and discuss your product requirements. The Exhibitor Reception on Tuesday, 21 September will allow you to combine business and pleasure in the exhibit area!

Watch for exhibitor raffles!

If you have any questions please feel free to contact:

Teresa Farris, US Exhibit Chair: Teresa.Farris@aeroflex.com

Christian Chatry, European Exhibit Chair: Christian.Chatry@trad.fr

Setup

Monday, Sept 20, 15:00 - 18:00

Tuesday, Sept 21, 8:00 - 10:00

Exhibition Hours

Tuesday, Sept 21, 10:30 - 19:30

Wednesday, Sept 22, 9:00 - 16:00

Thursday, Sept 23, 9:00 - 14:00

Exhibitors' social

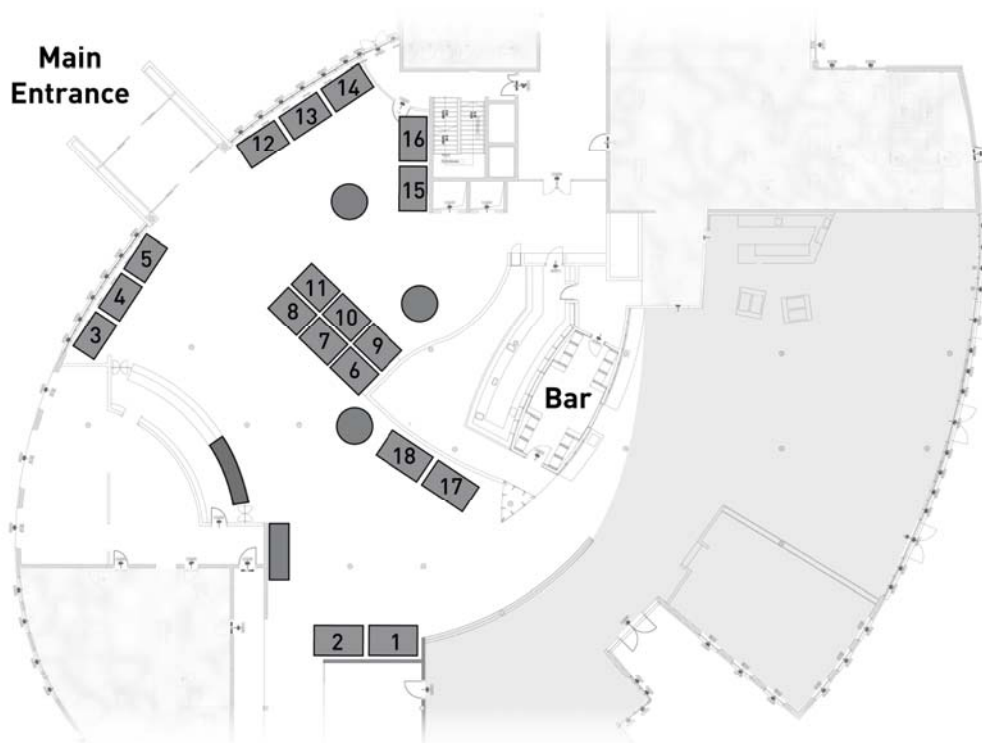
Tuesday, Sept 21, 18:00 - 19:30

Tear down

Thursday, Sept 23, 14:00 - 18:00

Industrial Exhibition – 20-23 September 2010

Industrial Exhibitor Booths



Booth No. 1	Isocom LTD	www.isocom.uk.com
Booth No. 2	The Svedberg Lab	www.tsl.uu.se
Booth No. 3	Actel Europe LTD	www.actel.com
Booth No. 4	Astrium GmbH, Space Transportation	www.astrium.eads.net
Booth No. 5	3D Plus	www.3d-plus.com
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Industrial Exhibition – 20-23 September 2010

3D Plus (Booth No. 5)

3D Plus is a worldwide supplier of advanced high density 3D microelectronic products and Die Stacking technologies. We offer radiation tolerant catalog products and more complex System-In-Package (SiP) solutions that bring breakthrough advantages to our customers' electronic designs, and focus on the demand for high-reliability and high-performance for space-saving technology-driven applications for space markets.

Actel Europe LTD (Booth No. 3)

Whether you're designing for sea-level or 2,000,000 miles into space, Actel's high reliability, low power FPGAs are your best choice. With a history of providing the most reliable, robust, low power flash and antifuse-based FPGAs in the industry, Actel FPGAs provide features and performance unlike those of traditional FPGAs. Only Actel can meet the power, size, cost and reliability targets that reduce time-to-market and enable long-term profitability.

Aeroflex (Booth No. 6)

Aeroflex Colorado Springs HiRel products include microcontrollers, logic, FPGAs, SRAM MCM and SDRAM memories, MIL-STD-1553 databuses, clocks, an LVDS and SpaceWire family and our new UT699R LEON 3FT Microprocessor. Our RadHard-by-Design ASICs handle design complexities up to millions of gates. Aeroflex Gaisler offers IP and LEON processor solutions.

Astrium GmbH, Space Transportation (Booth No. 4)

The unit "Electrical Engineering & Qualification" of ASTRIUM ST does not only care about avionics architectures, but also provides avionics equipments to various spacecraft, predominantly in the manned space business. We cover the complete product life cycle in-house, including engineering services, development and production. Further we offer radiation test and analysis services to external customers

Atmel (Booth No. 12 & 13)

ATMEL is the European Space Digital IC manufacturer. Catalog includes SPARC Processors, SRAMs, EEPROMs, FPGAs and ASICs. Products are generally radiation hardened against TID 300Krad, SEL immune @70Mev and SET free @40Mev. ATMEL launches now Radiation Hardened by Design SRAM based FPGAs enabling in-flight reconfiguration and prepare Reprogrammable SPARC Processor.

Boeing (Booth No. 8)

The Boeing Company's Solid-State Electronics Development (SSED) organization performs application specific integrated circuit (ASIC) design and technology development for numerous Boeing programs and external customers. SSED designs include digital, analog, RF/MMIC, and system on chip. SSED specializes in radiation-hardened and extreme environment ASIC design. Over the past 20 years, SSED has developed over 450 integrated circuits for commercial, government, and space applications. Boeing is the world's largest military aircraft manufacturer, and a leading supplier of satellites, space exploration systems, and national asset defense articles.

C-MAC MicroTechnology (Booth No. 11)

C-MAC MicroTechnology manufactures high-reliability electronic systems, modules and components for aerospace & defence applications. Our product range includes MIL-STD-1553 and 1760 databus products supported by AS9100 and MIL-PRF-38534 Class K certification. C-MAC's innovative partnership agreements provides the European Space market with class leading analogue and digital products from a UK production and test facility.

Interpoint, a Crane Company (Booth No. 18)

Interpoint, a Crane Co. Company, manufactures high-reliability power conversion products with proven performance in the extreme environments of space and defense. An industry leader for over 39 years, Interpoint is fully qualified to MIL-PRF-38534 Class K and has an RHA program approved by DSCC. Microwave products are also available from sister company Merrimac.

Industrial Exhibition – 20-23 September 2010

Intersil (Booth No. 7)

Intersil's history and experience in the space and defense industries span almost five decades. Today, Intersil continues to develop and support new SMD, /883, and Class-V/Q radiation hardened products for the most demanding applications in the Space marketplace. All Intersil SMD products are MIL-PRF-38535/QML compliant and are 100% burned in.

Isocom LTD (Booth No. 1)

RADIATION HARD OPTOCOUPPLERS

ISOCOM is a European Manufacturer of High Rel Hermetically Sealed Optocouplers and custom components including Radiation Sensors, LEDs and Detectors. QUALITY ASSURED Approved to UL; IECQ-CECC and ISO9001:2008. Compliant with MIL 883; MIL-M-38510; MIL-S-19500 and VDE.

Isotron LTD (Booth No. 9)

Isotron Limited is a leading provider of space radiation environment testing. Utilising the core technologies of Gamma, Electron and Ion Beam Irradiation, Isotron can provide a range of testing services to assess the resistance of components, materials and systems to TID, proton and electron irradiation.

Lewicki Microelectronic GmbH (Booth No. 14)

Manufacturing of customized Hybrids, hermetic encapsulation of high-rel components (Assembly & Testhouse for space components – qualification for rad tolerant Power MOSFETs in progress / DLR contract); Delivery of complete radiation tolerant Photodiodes / -modules. Manufacturing and test capabilities according MIL / ESCC. EN 9100 certified.

Maxwell Technologies (Booth No. 10)

Maxwell Technologies Microelectronics provides high performance, space qualified single board computers and components. The SCS750® single board computer lowers risk and increases flexibility by providing 200-1800 MIPS of processing power and an upset rate of better than once every 30 years. Maxwell's space qualified components include memories and data converters.

STMicroelectronics (Booth No. 15)

STMicroelectronics, 1st European semiconductor supplier (5th worldwide) , proposes a broad portfolio of Aerospace Discrete, Logic, Analog and Power components, mostly designed specifically to the highest radiation and reliability demands of the aerospace industry. Uncompromised manufacturing quality is ensured by its Rennes (FR) facility, ESCC qualified without interruption for over 30 years.

Texas Instruments Deutschland GmbH (Booth No. 17)

Texas Instruments HiRel Medical, Defense and Aerospace organization is a global supplier of parts for harsh environment. Texas Instruments' High Reliability Division has an expanding portfolio of analog and digital devices for implementation in the Space environment. The Components are characterized against various radiation effects, extended temperature effects, and evaluated for extended operating lifetimes, such as 15 year satellite missions

The Svedberg Lab (Booth No. 2)

TSL offers high intensity particle beams for accelerated radiation testing of electronics. With Large user area – For bulky or tiny devices, Atmospheric-like neutron spectrum – Adequate testing, and Logistics assistance – Ease your work. The facilities are located in Uppsala, less than one hour from Stockholm airport.

TRAD (Booth No. 16)

TRAD radiation experts team can provide you with :

- an evaluation of the impact of radiations on your project.

Thanks to the engineering tools developed by our software team (OMERE, FASTRAD...), we allow you to optimize significantly the radiation process.

- a test of any class of components under any type of radiations.

TRAD can test any class of components under irradiation. We study the response of components submitted to either protons, electrons, heavy ions, gammas or neutron beam.

General Conference Information

Registration Desk and Conference Secretariat

Registration is mandatory to access the RADECS 2010 Conference at the Aqua Dome Längenfeld. All further information and the registration are provided online at the RADECS 2010 website www.radeecs2010.ait.ac.at and at the RADECS 2010 onsite registration desk.

Conference Secretary Office

The registration desk will be open:

Sunday, 19 September, 17:00 – 19:00

Monday, 20 September, 07:30 – 17:00

Tuesday, 21 September, 07:30 – 17:00

Wednesday, 22 September, 07:30 – 15:00

Thursday, 23 September, 07:30 – 15:00

The Conference Secretariat / Registration desk will be open to assist you with any queries you might have related to the conference secretariat.

Internet Access

A wireless Internet connection will be available in the conference area. Additionally, standalone Computers with fixed internet connection will be accessible in the “LAN Internet” area.

Message Board

A message board will be located near to the conference room. You can get general information also at the registration desk. In emergency case you can call the technical vice-chair, Mr. Marcin Latocha (Tel.: +43 664 235 1815)

Preview Room

A preview room is set up just opposite to the main conference room. Software used in the preview room is identical to that used in the conference room. Speakers are requested to make use of this facility. Please test and upload your presentation on time, according to the “Oral Presentation Instructions for the RADECS 2010 Conference” note provided to you earlier.

Break Refreshments

During the breaks in the technical program coffee, tea, fruits, snacks and other refreshments will be served in the Industrial Exhibition area. During the Radiation Effects Data Workshop and Poster Session the coffee break is also served close to the poster rooms.

Lunch

A lunch buffet and a drink will be offered to participants of the Thematic Workshops on Monday at the Aqua Dome restaurant for those who registered for the lunch. Please show your “Monday-Lunch-Ticket”. Between Tuesday and Friday for all participants of the conference a lunch buffet and a drink is offered. Please show your conference badge. The access to the lunch is granted to the participants of the conference. For guests a limited number of lunch tickets are available. Please contact the registration desk. You must order the ticket latest by 12:00 the previous day.

Non-Smoking Policy

The conference will have an overall non-smoking policy at the whole conference area!

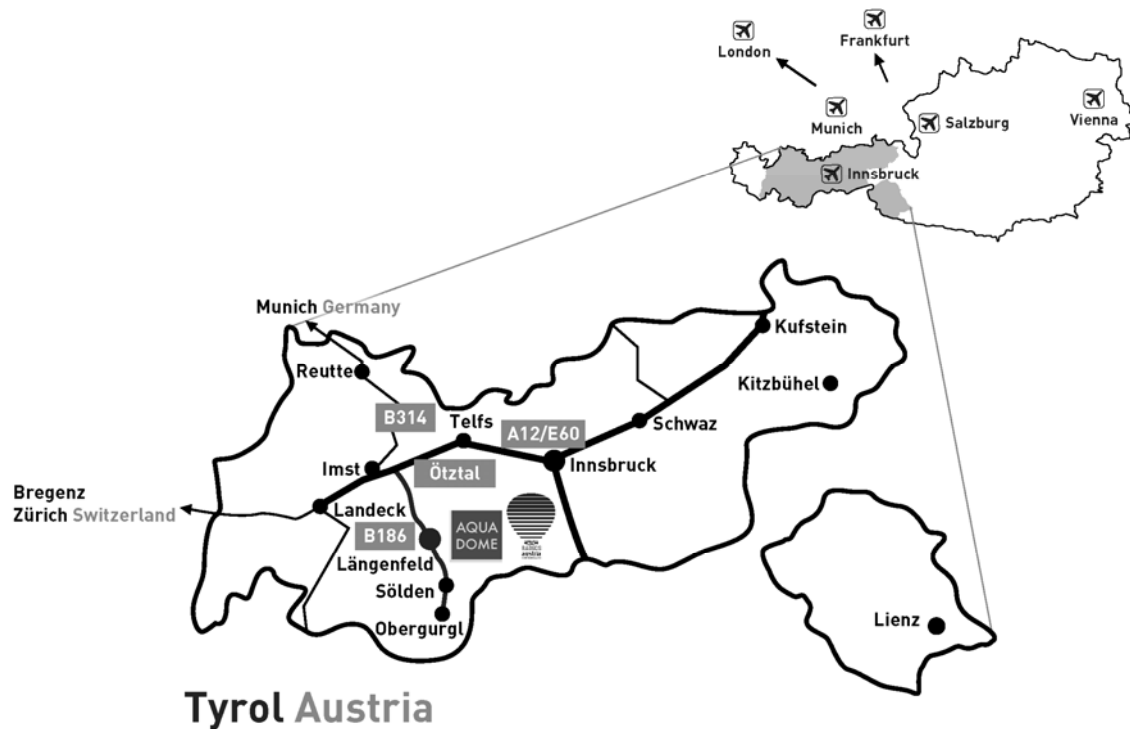
Climate

The weather is usually stable in September around 15°C. You should be prepared for changes as it is usual in a mountain area of 1200 m (~4000 ft) altitude.

Liability

By registering into the Conference and/or by participating in the exhibition joined to the Conference, participants and exhibitors agree that neither the Organizing Committee nor the Administrative Secretariat assume any liability. Participants and exhibitors are advised to organize their own health, travel and personal insurances.

Travel Information



Take the Inntal highway A12/E60 and exit at Ötztal into the Ötztalstraße B186 (Ötztalstreet). Pass Sautens, Ötz and Umhausen. After approximately 22 kilometer you reach Längenfeld.



Take the train to Ötztal train station, continue with the regional bus 4194, which has the final destination: „Obergurgl Zentrum“, till Längenfeld. Duration: approximately 40 minutes. From Innsbruck there is a train leaving from the central railway station to Ötztal train station.

For further information please visit www.oebb.at/en/



The nearest airports are: Innsbruck, Salzburg or Munich. Daily flight connections to Innsbruck are from Frankfurt, London and Vienna.

For all further information please contact the conference hotel www.aqua-dome.at

Social Programme and Tours

Welcome Reception at the Town Hall Längenfeld

Monday, 20 September, 19:00 – 20:30

The Mayor of Längenfeld offers a welcome reception to all the participants of RADECS 2010 Conference and their accompanying persons. The reception will take place at the Town Hall of Längenfeld on Monday, 20 September, starting at 19:00. The reception is free of charge. Pre-registration is mandatory.

Address:

Gemeindeamt Längenfeld
Oberlängenfeld 72
6444 Längenfeld

Welcome Reception at the Conference Hotel

Tuesday, 21 September, 18:00 – 19:30

All participants of the RADECS 2010 conference and their guests are invited to the Welcome Reception at the Conference Hotel. The reception will take place on Tuesday, 21 September, starting at 18:00. The reception is free of charge. Pre-registration is mandatory.

Tyrol Evening

Wednesday, 22 September, 16:30

“Tyrol Evening” (Tiroler Abend) – an event with traditional Tyrolean dinner and local music performance in a traditional mountain shelter. Number of tickets is limited. Tickets can be ordered online or at the onsite registration desk. Booking is closed on Tuesday, 20 September 2010, 12:00.

Gala Dinner

Thursday, 23 September, 19:30 - 23:00

Conference participants are invited to the Gala Dinner which will take place on Thursday, 23 September, starting at 19:30 at a secret location close to the conference hotel. The dress code is business casual. Participation at the Gala Dinner is also available for accompanying persons. Tickets can be ordered online or at the registration desk. Booking is closed on Tuesday, 20 September 2010, 17:00.

Social Programme and Tours

Tours

During the conference several one day tours are organized to Salzburg, Meran, Innsbruck, Swarovski Crystal Worlds, Neuschwanstein, to Munich and the Oktoberfest.

REGISTRATION CLOSES ONE DAY BEFORE THE TOUR

For booking information please contact:

ÖTZTALER Verkehrsgesellschaft m.b.H.
Öztalerstrasse 2, A-6450 Sölden
Tel: +43 5254 3550
Fax: +43 5254 3550 50

Email: jasmin.noesig@oetztalerbus.at
Web: www.oetztalerbus.at

BOOKING CODE: RADECS 2010

TOUR 1: Salzburg Tuesday, 21 September

Route: Längenfeld-St. Johann in Tirol-Lofer-Salzburg-Kufstein-Längenfeld



In the morning we drive from Längenfeld from your Hotel via St. Johann in Tirol and Lofer to Salzburg. At about 12.30h we arrive in Salzburg where you make a guided city tour with an English speaking city guide. After the city tour everybody can spend his time on his own. At 14:30h the bus drives back to your hotel in Längenfeld.

Departure Time: 08:30
Arrival Time: 18:30
Price: € 30,- (per Person)

Social Programme and Tours

TOUR 2: Meran and Castle Trautmannsdorf **Tuesday, 21 September**

Route: Längenfeld-Reschenpass-Meran-Reschenpass-Längenfeld



In the morning we drive from Längenfeld from your Hotel via the Reschenpass to Meran. Everybody who wants can step out of the Bus and can go to Castle Trautmannsdorf. If you don't want to stay there the Bus will bring you to the city centre of Meran. In the City you can spend your time on your own for Shopping or Sightseeing. At about 14:00h we drive again via the Reschenpass back to the Hotel.

Departure Time: 08:30

Arrival Time: 16:00

Price: € 30,- (per Person)

TOUR 3: Innsbruck and Swarovski Crystal Worlds **Wednesday, 22 September**

Route: Längenfeld-Innsbruck-Wattens-Längenfeld



In the morning we drive via the high way to Innsbruck to the City centre where you make a city tour with an English speaking city guide. After about one hour you can spend about 2 hours for shopping or anything else. At about 12.00h we drive to Wattens to the Swarovski Crystal Worlds where everybody can spend about 2 hours on his own. At 14.30h we drive back to the hotels in Längenfeld.

Departure Time: 08:30

Arrival Time: 16:30

Price: € 35,- (per Person)

(Entrance fee for Swarovski Crystal Worlds and the city guide included)

Social Programme and Tours

TOUR 4: Königsschlösser Neuschwanstein Thursday, 23 September

Route: Längenfeld-Fernpass-Füssen-Schwangau-Längenfeld



In the early morning we drive via the Fernpass to Schwangau where the castles Neuschwanstein and Hohenschwangau are. At about 10:00h we will be in Schwangau and there we have a guide for Neuschwanstein. After the tour you can spend your time on your own. At about 14:00h we will drive back to your hotel in Längenfeld.

Depature Time: 08:00

Arrival Time: 16:00

Price: € 40,- (per Person)

(Entrance fee for the Castle Neuschwanstein and the guided tour included)

TOUR 5: Munich and the Oktoberfest Friday, 24 September

Route: Längenfeld-Seefeld-Garmisch-Munich-Garmisch-Seefeld-Längenfeld



In the late afternoon we drive to Munich where we have a city tour with an English speaking guide. After this the bus brings you to the "Oktoberfest" where you can spend your time on your own until 23:00h. At 23:00h the bus brings you back to your hotel in Längenfeld.

Depature Time: 14:00

Arrival Time: 03:00 (Saturday Morning)

Price: € 50,- (per Person)

Social Programme and Tours

AREA 47: The new highlight at the entrance to the Ötztal Valley.



Nature and high-tech combined to an extraordinary recreational experience for everyone. Whether outdoor adventure, event arena, water action, entertained dining or a stage for business incentives – the 6.5 ha location at the 47th latitude between HAIMING, SAUTENS and ROPPEN leaves nothing to be desired.

For additional information visit <http://www.area47.at/en/home/info/anfahrt/>

Golfpark Mieminger Plateau



A round of golf in the heart of the Alps, full of fun, sporting challenge and pure nature with unique panorama of the Tyrolean mountain world is waiting for you. If you wanted to play in such beautiful surroundings always dreamed about golf, then the 27 hole Golf Park Mieminger plateau is determined exactly the right place for you.

For additional information visit www.golfmieming.at (website in German only) or contact directly via telephone: +43/5264/5336 or e-mail: golf@mieming.at

Social Programme and Tours

Additional hiking tours



Monday, 20 September

Hike to the Stuibenfall and visit of Ötztal

Meeting point: 10:00 am at the AQUA DOME Hotel Lobby

Duration: 10:00-01:00 PM

Price taxi & entrance: EUR 16,-

We walk along the biggest waterfall of the Tyrol over the rope bridge to the old street of Niederthal. From there we walk back to the Ötztal. An open-air archaeological park, the visitors' lives and way of life in the Neolithic Age, the time Ötzi's meant to illustrate.

There you will have the opportunity to eat lunch at the lake restaurant.



Tuesday, 21 September

Panoramic tour to the Hahlgogelhaus (2042m)

Meeting point lake hike: 9:00 am at the AQUA DOME Hotel Lobby

Duration: 09:00-01:00 PM

Price taxi: EUR 6,-

The taxi will take us to Huben. There we hike over a forest track to the old beautiful mountain cottage "Hahlgogelhaus". On the way to the cottage, we have a beautiful overview of the valley and Längenfeld surrounded by all the 3.000m high peaks. After a lunch break in the hut we go back to Huben.



Wednesday, 22 September

Visit of the museum of local history

Meeting point: 10:00 AM at the AQUA DOME Hotel Lobby

Duration: 10:00-11:00 AM

Price entrance: EUR 4,-

From the hotel we walk to the museum. This wonderful museum documents the rural living and famous way of life in the Ötztal valley up to the 50ies. After a tour through the museum we walk back to the hotel.



Thursday, 23 September

Hike to the "Piburgerlake"

Meeting point: 10:00 AM at the AQUA DOME Hotel Lobby

Duration: 10:00-01:00 PM

Price taxi: EUR 11,-

Equipment: hiking boots, rain protection, beverages

The taxi drives us to Tumpen and from there we hike over easy path called "Seejochl" to the "Piburgerlake". There we have lunch at the restaurant directly at the lake. The "Piburgerlake" is at an elevation of 914m and is under nature protection.

All tours are subject to modification due to weather changes. Please register via e-mail: veranstaltung@aqua-dome.at or at the Aqua Dome Registration Desk.

Contact: Sascha Roessel

E-mail: veranstaltungen@aqua-dome.at

Tel: +43 (0) 5253 6400-402

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